SCIENTIFIC AMERICAN

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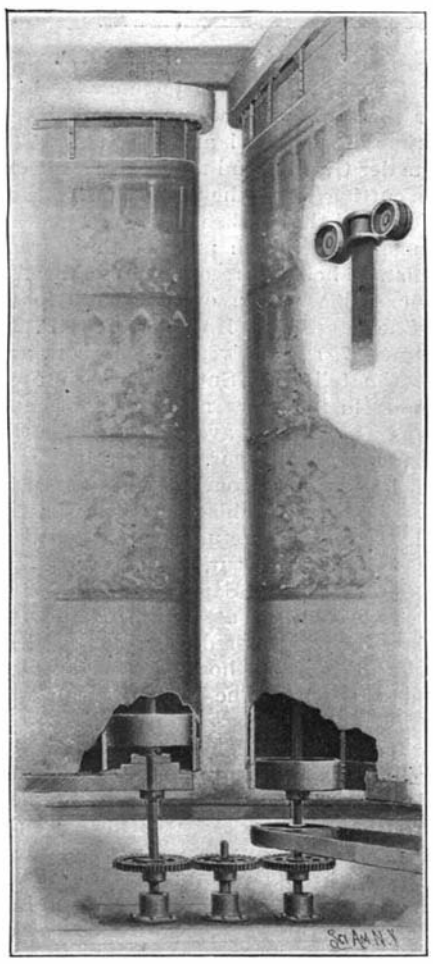
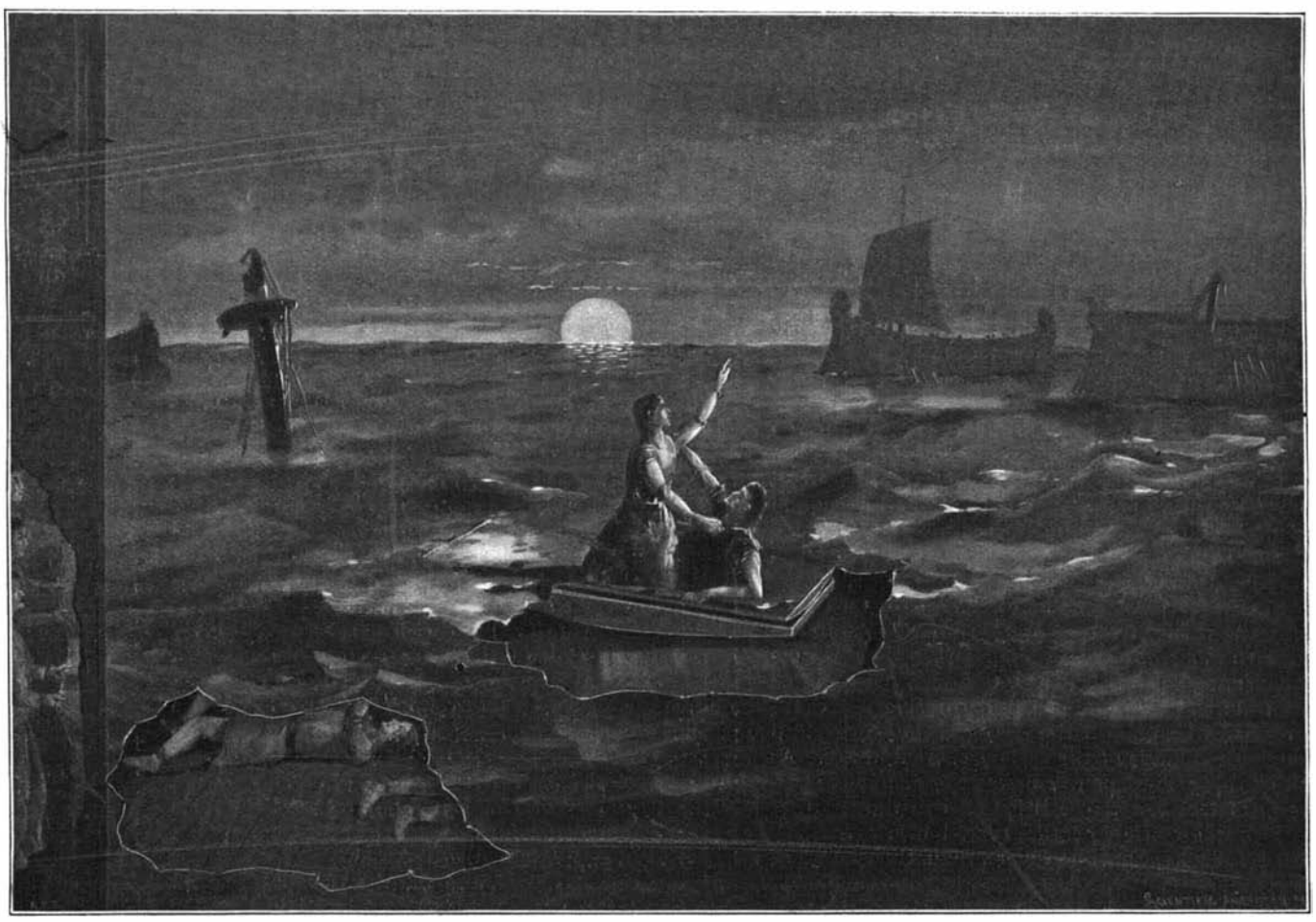
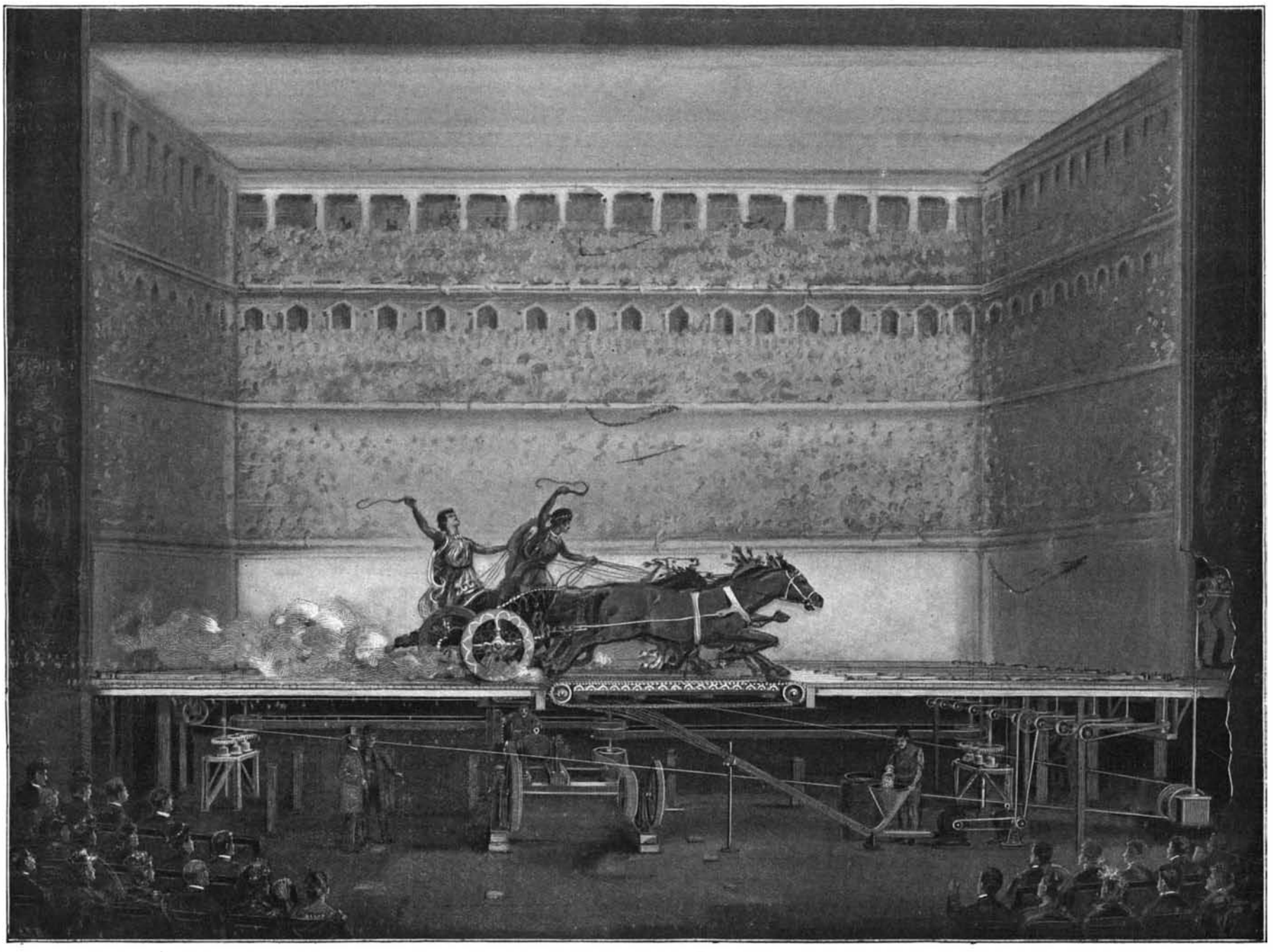


Detail of the Panoramas.

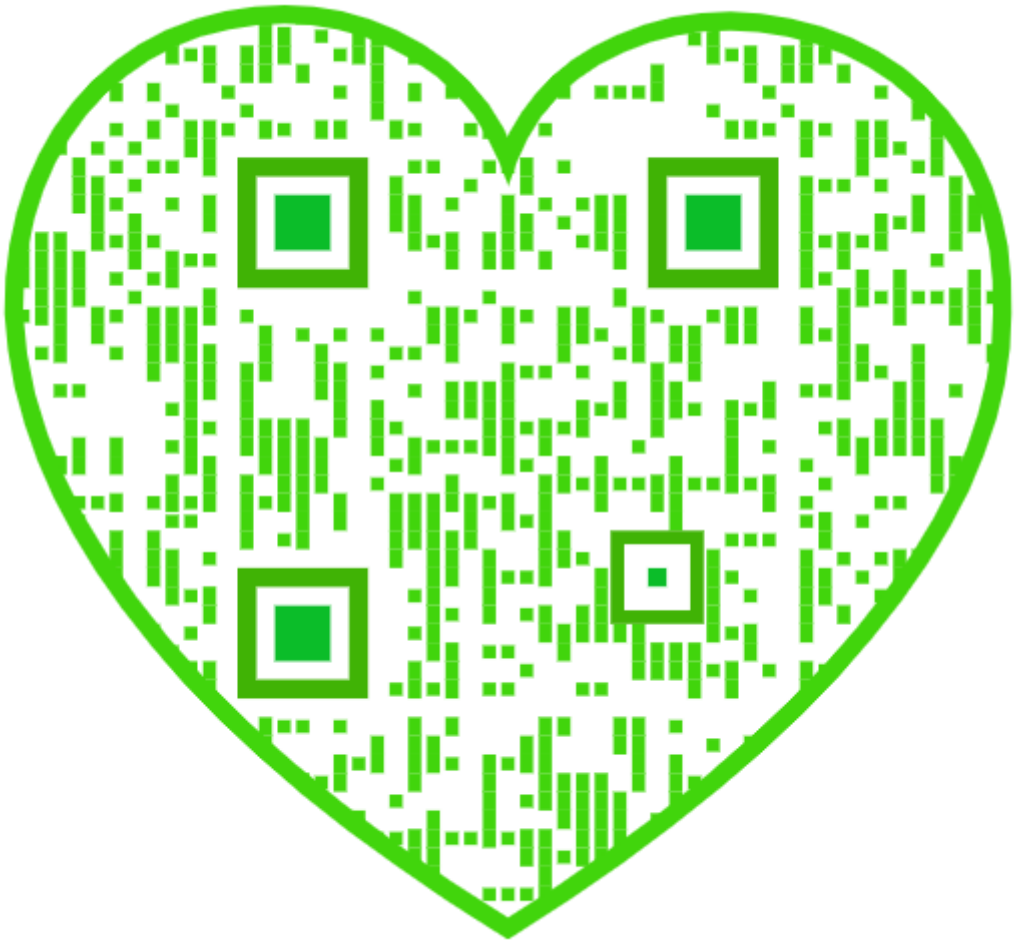


The Wreck Scene in "Ben Hur," Showing the Simple Mechanism Employed.



The Chariot Race in the Circus of Antioch—Ben Hur Destroys Messala's Chariot and Wins the Race.

SOME OF THE STAGE MECHANISM OF THE PRODUCTION OF "BEN HUR" AT THE BROADWAY THEATER, NEW YORK.—[See page 119.]



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NEW YORK, SATURDAY, AUGUST 25, 1900.

PROGRESS OF THE NEW YORK RAPID TRANSIT TUNNEL.

Although five months have passed since the contract for the construction of the New York Rapid Transit Tunnel was signed, there is as yet but little evidence of the general upheaval of the streets of this city, which it was popularly supposed would follow immediately upon that event. This has not been due to any lack of zeal upon the part of the contractor-in-chief, or the sub-contractors, but it is to be laid to the charge of the steel works which have undertaken the task of supplying the 78,000 tons of structural steel and steel rails which are necessary for the tunnel. The plans of the tunnel call for a subway, the side walls and roof of which consist of steel posts and girders embedded in and backed with concrete. With the exception of three or four miles of straight rock tunneling, the whole of the excavation will lie so near the surface that it will constitute what is known as cut-and-cover work; that is to say, the excavation will be made from the surface down, and the side walls and the roof will be built in the deep cut thus opened up through the middle of the various thoroughfares. As work of this class demands more or less complete suspension of traffic, a clause is inserted in the contract by which no section of the tunnel below Sixtieth Street is to be kept open for more than thirty days at a time.

From the very nature of the construction of the tunnel, it is necessary that the steel should be on the ground if only thirty days is to elapse between the breaking of the ground and the roofing in of the tunnel; and it is mainly for this reason that the sub-contractors have so far devoted their efforts merely to the lowering of the sewers, and the building of storage sheds for the accumulation of the excavating and other contractors' plants. It is stated by the engineer-in-chief for the contractor, that the question of the rapidity of the construction of the tunnel will be a question of the rapidity of the delivery of the steel; and just as soon as this material begins to arrive in any quantity the people of New York will see immediate evidence that this, the largest undertaking of its kind in the world, is being vigorously prosecuted. At the present writing the whole of the sub-contracts have been let, and the work of lowering the various sewers, which at present intercept the line of the tunnel, is being pushed forward. The most important diversion is that of the Canal Street sewer, which is more than half completed. The sewers at Mulberry Street, Eleecker Street, and Tenth and Twenty-second Streets, have been lowered, while the change of the sewers at One Hundred and Tenth Street, One Hundred and Twenty-fourth Street and One Hundred and Fifty-seventh Street is approaching completion. In spite of the serious delay which has already been occasioned by the non-delivery of steel, the contractors express themselves as perfectly satisfied that the road will be finished before the contract date set for completion.

HIGH-LIFT LOCKS FOR THE ERIE CANAL.

The question of the introduction of high-lift locks on the Erie Canal, in place of the low-lift locks at present in use, is being investigated by a special board of engineers. Three different types have been considered. The first of these is the Dutton pneumatic balanced lock, illustrated in the SCIENTIFIC AMERICAN of February 3, 1900, which was reported upon favorably by the canal officials in 1896. This system contemplates the use of two balanced lock chambers, placed side by side, with a lift in the case of the locks at Cohoes of 150 feet, and of the locks at Lockport of 66½ feet. Each lock chamber is carried on a huge inverted air-tight caisson, which works vertically in an excavated chamber filled with water. The system is so arranged that when one lock chamber is elevated to the upper level, the adjoining chamber is at the lower level. The air caissons are connected by a system of pipes and intersecting valves, so arranged that when an excess of weight is placed upon the upper tank, it will descend, driving the air from its own air caisson through the connecting pipes into the adjoining caisson, which in its turn is raised to the upper level. Plans were also inspected, which have been presented by Messrs. Morse & Brown, for two distinct designs of locks; one worked on a cable counterpoise system, and the other calling for a system of hydraulic-lift locks. The design provides for balancing one lock chamber with another which is exactly similar, the two being connected, not as in the case of the Dutton system by large air pipes, but by a number of wire cables which pass over a system of sheaves and are provided with safety appliances to prevent a sudden drop in the case of the failure of any part of the balancing gear. The plans for the hydraulic lift call for two lock chambers, each of which is raised and lowered by means of three hydraulic plungers and cylinders, the locks being arranged to counterbalance each other by means of the suitable manipulation of connections between the two sets of cylinders. There is also under consideration, by the Board, plans of Mr. William R. Davis for a counterpoise lift lock, in which a pair of counterbalancing tanks are raised and lowered upon a dozen steel towers, at the top of which are 24-foot sprocket wheels, on which travel the flat link chains which support the tanks. The latter, which weigh about 5,500 tons each when loaded, are to be raised and lowered by electric power, which is to be developed by turbine wheels operating under the head of water due to the total difference of the level of the canals. One of the most important subjects under consideration by the Board is the question of the amount of water and the total time which are required for effecting the entire lift with locks of the different kinds above described.

Whether the proposed enlargement of the Erie Canal is carried out or not, it would certainly be of enormous advantage to the canal system, as it now exists, if the low-lift locks could be abolished at Cohoes and Lockport and a system of high-lift locks established. At Lockport there are five locks with an average lift of 11½ feet, while at Cohoes there are no less than sixteen locks with an average lift of 9 feet. At these two locks alone it is estimated that over half a day is lost in the passage of a single tow.

RECENT ARMOR PLATE BIDS.

The Secretary of the Navy has rejected the bids which were made for furnishing armor for the fourteen battleships and armored cruisers which are either building or authorized, and for the three authorized cruisers of the protected type. Advertisements for new bids have been issued, and the opening will take place within about a month. The bids were rejected, not on the question of price, but because of the somewhat complicated nature of the three proposals which were submitted to the Department. The three bidders were the Midvale Steel Company, and the Carnegie and Bethlehem Companies. The Midvale Steel Company stated that it would not accept a contract for less than 20,000 tons of armor, while the Carnegie and Bethlehem Companies stated that they each would not accept a contract for less than 18,250 tons of armor. As the total amount of armor asked for by the Department was about 35,000 tons, to give a contract for 20,000 to the Midvale Company would leave about 15,000 tons only to be divided between two companies, who had each refused to accept a contract for less than 18,250 tons. This would have involved that new bids for at least 15,000 tons must have been advertised for. While this could have been done, and would have been more liable to satisfy the Department, there was a difficulty in the way due to the fact that the Midvale Company asked for twenty-six months in which to perfect an armor plant, and begin making deliveries.

In view of the fact that the armor for the three battleships of the "Maine" type will have to be delivered at an early date if the Department is to avoid delay in their construction, it will be seen that the acceptance of the bid of the Midvale Company was altogether out of the question. The Carnegie and Bethlehem Companies agree to begin making deliveries of armor in six months from the date of the contract, and the Department has, therefore, rejected all the bids in the hope that they will procure satisfactory bids for an amount smaller than 18,250 tons each from the last named companies.

There is much satisfaction to be derived from the fact that the bidding came well within the limit of the price laid down by Congress. The Secretary is authorized to buy the best armor procurable for $445 a ton, but if he could not get it at that rate, he might accept a bid as high as $545 a ton, and if he could not get it at the higher figure, he was authorized to erect a government armor factory. On opening the bids it was found that both the Bethlehem and Carnegie Companies asked the same price for their armor, namely, $490 a ton, with the royalty paid by the bidder, or $445, with the royalty paid by the government. This is a considerable and a very satisfactory drop from the $545 per ton formerly demanded by these two companies. The bid of the Midvale Company was somewhat less than that of the others. It is gratifying to know that a third large steel concern is prepared to undertake the manufacture of armor plate with the stipulation that if it undertakes to supply armor, it shall receive a contract for the large amount of 20,000 tons. This reservation is due to the very natural desire of the company to make sure that, as soon as it erected its costly armor plate mills, it would be enabled to make sufficient armor to recoup itself for the outlay. At the same time it was simply impossible for the government to tie itself up to a delay of twenty-six months in the receipt of this particular consignment of armor. We sincerely trust that the new bids will include some provision which may include the Midvale plant and be mutually agreeable to the company and the government.

LOWERING OF THE ATLANTIC RECORD.

Not a little excitement is prevalent just now in shipping circles over the steady reduction which is being made in the time of trans-Atlantic passage. The "Kaiser Wilhelm der Grosse" and the new "Deutschland" have been cutting down the time of the passage between New York and the English ports by hours at a trip. The former vessel, which prior to the advent of the "Deutschland," held all records across the Atlantic, made a magnificent run on her last trip to the eastward. She left Sandy Hook at 12:23 P. M. on Tuesday, August 7, and arrived at Cherbourg at 12:57 P. M. on the following Sunday, covering the course of 3,184 miles in five days nineteen hours and forty-four minutes, at an hourly average speed for the whole trip of 22·79 knots an hour. On her best previous record run her average hourly speed was 22·61 knots per hour. The "Deutschland," which, it will be remembered, on its first return trip attained a speed of exactly 23 knots an hour, left New York on Wednesday, August 8, passing Sandy Hook at 3:35 P. M., and arrived at Plymouth at 8:30 A. M., on the following Monday, having covered the course in five days eleven and three-quarter hours, at an average speed of 23·32 knots an hour. The best day's run was 552 knots.

An interesting fact in connection with these records, is that the "five-day-boat" is now an accomplished fact, for a speed of 23 32 knots an hour, if maintained over the route from Sandy Hook to Queenstown, would bring the record down below five days, or to be exact, to four days twenty-three hours and six minutes. The record over this route is now held by the "Lucania," which covered the distance of 2,778 miles in five days seven hours and twenty-three minutes. The "Lucania," however, is now a relatively "old boat," having been built in 1892-1893; and as the interval between "Lucania" and "Deutschland", is about eight years, we may say that the reduction in the time of the trans-Atlantic passage has been proceeding at the approximate rate of an hour a year.

COMPRESSED AIR TRACTION IN NEW YORK CITY.

An important change is being effected in the compressed air system of traction on certain lines in this city, by the substitution of what is known as the Hardie motors for those now in operation, which were built under what are known as the Hoadley patents. What might be called the modern development of compressed air traction in New York dates from about the year 1897, when the promoters of the two types of motor mentioned above were engaged in active experimental work, the Hardie system being tried on the Third Avenue Railroad, and the other on the lines of the Metropolitan Street Railway Company. Both motors operate under extremely high pressures of from 2,000 to 2,500 pounds to the square inch; but here the difference ends. In the Hardie system two long-stroke, single-expansion engines are employed, which are directly connected to one axle of the car, the other axle being driven by side rods. The air, after being reduced to the working pressure by a reducing valve, passes through a tank of hot water, and is then led in a super-heated condition to the cylinders. The Hoadley motor differs from this mainly in the fact that a complete two-cylinder, compound engine is carried on each truck and drives a shaft which is geared down to the car axle. Instead of passing the air bodily through the tank of hot water, a small jet of water is sprayed into the air pipe between the reducing valve and the cylinders.

The Hoadley system was adopted by the Metropolitan Street Railway Company, while the Hardie system has been for some time in successful operation on the North Clark Street Railroad, Chicago. The recent amalgamation of the two companies has resulted in the adoption of a motor designed chiefly upon the lines of the Hardie system, which will shortly replace the motors now in use upon the crosstown lines of the Metropolitan Street Railway system. The present compressing station, which is located at the foot of West Twenty-fourth Street, will be utilized, and it is expected that before very long the new motors will be in operation. Mr. Hardie, who is the chief engineer of the Consolidated Compressed Air Company, which now has control of the patents covering both systems is one of the oldest and most indefatigable workers in the field of compressed air traction, and the success of the new

venture will be watched with considerable interest by the Metropolitan Street Railway Company, to whom the development of a really satisfactory independent motor for their crosstown lines seems to be almost an imperative necessity.

LIMITS OF ELECTRIC TRANSMISSION.

BY ALTON D. ADAMS.

The electric transmission of power at pressures that render the conducting wires luminous, cause hissing sounds, and produce a certain sensation in the observer at several feet distant, is being ably exploited. Referring to the subject, a recent writer has said: "The most fundamental present question is the limit of practicable voltage." Again it is stated that, referring to experiments with electric transmission at high pressures, "The carrying out of such experiments has a vital interest far beyond the mere utilization of distant water powers. It may, and very possibly will, open up the way for the wholesale transmission and distribution of power from coal." To fairly consider this question, the clear distinction between the long distance transmission of power and its distribution should be held clearly in mind.

It may, for example, be shown that a cheap and distant power is, or can be, transmitted to a center of population and there distributed to consumers at a profit; but this is not the question at issue. The real problem is whether the cheap and distant energy can be delivered at one or more convenient points, in or near the center of population, at a cost per unit that shows a saving over energy there generated from coal. It is a well-known and demonstrated fact that a central electric generating station in or near a town or city can supply power to a great number of small consumers on a sound economic basis for all concerned, because the generating station can develop power from fuel at a much less cost per unit than can the small user. It remains, however, to be proved that energy from a cheap source, 100 or 200 miles distant, can be transmitted to this central station and there used to drive the dynamos for the local service, thus displacing their engines, at a profit. If the transmitted power is to be used in a great manufacturing establishment, the question remains about the same as when it is destined for a distributing plant, since in either case power can be economically developed from coal at the point of delivery.

When a source of cheap fuel invites the transmission of power there developed to great centers of distribution or consumption, the saving in the cost of fuel per unit of energy delivered over that produced at that center is the chief economic reason for the transmission. The real question of electric power transmission, in large units, over great distances, is whether the saving in fuel warrants the investment in line and machinery and their attendant losses. In power production, the cost of fuel is neither the only nor in most cases the largest expense, and a part of the fuel cost is all that can be saved by the electric transmission. The long distance transmission of power is an undertaking that involves a large investment, and it is only fair that when the cost of power generated near the point of use is to be compared with that of the transmitted power, figures should be based on first-class results in a local plant conducted on a large scale. Considering two steam plants, one at a long distance, where fuel is cheap, and the other at the center of use or distribution, an equal economy in the weight of fuel consumed per unit of energy developed should be assumed, the cost of fuel in each case per unit of delivered energy computed, and the difference found. The price of steam coal that will develop a horse power hour at the engine shaft, in a first-class steam plant, on a consumption of 2·5 pounds, is not more than $3 per ton of 2,000 pounds in most cities of the Central and Eastern States.

Allowing 3,000 working hours per year, the cost of coal per horse power per year is $(2{\cdot}5 \times 3000 \times 3) \div 2000 = 11{\cdot}25$ dollars. If the steam generating plant is moved to the vicinity of the mine, this same quality of coal can be had at a much lower figure, say $1 per ton, and the fuel cost per brake horse power hour will then be $(2{\cdot}5 \times 3000 \times 1) \div 2000 = 3\ 75$ dollars. The apparent saving in fuel by this change of location for the generating plant cannot all be realized, because, to deliver one horse power at the point of use or center of distribution, more than this rate of work must be maintained at the shaft of generating engines to make up for transmission losses. To determine these losses, the elements of the electric transmission system must be considered. To take power in the form of mechanical motion at one point and deliver it as mechanical motion at another point a long distance from the first, by electric means, requires at the generating station dynamos and step-up transformers; at the receiving station, step-down transformers and electric motors; also a line of conductors connecting the two stations. A good average efficiency under the varying conditions of load for the dynamos and motors is 90 per cent each, and for the transformers 95 per cent each. The efficiency of the line will vary inversely with the outlay for conductors, but would seldom be more than 85 per cent for a very long distance transmission.

These figures give the complete transmission system, from engine shaft to motor shaft, an efficiency of $0{\cdot}90 \times 0{\cdot}95 \times 0{\cdot}85 \times 0{\cdot}95 \times 90 = 0{\cdot}62$. For each horse power delivered at the motor shaft, the engine must, therefore, supply $1 \div 0{\cdot}62 = 1{\cdot}61$ brake horse power, costing for fuel alone $3{\cdot}75 \times 1{\cdot}61 = 6{\cdot}03$ dollars. As the plant located in a large city consumed fuel to a value of 11·25 dollars per brake horse power year, the saving as to fuel by the power transmission is $11{\cdot}25 - 6{\cdot}03 = 5{\cdot}22$ dollars per horse power year delivered by the motor. To effect this saving in the cost of fuel, the capacity of the steam plant has been increased 61 per cent and the entire electrical equipment added. The items of interest, depreciation, and repairs should now be computed for these additional investments. As the idea seems to prevail, in some quarters, that electrical transmission on a grand and general plan will be commercially practical, if only a sufficiently high working voltage can be employed to hold in bounds the weight and cost of line conductors, the cost of connecting wires and supports is entirely omitted from the following estimate, this being more favorable to the long distance electric transmission than any increase in pressure can possibly be. This omission is made with confidence that the necessary investments and losses, aside from the line, are so heavy as to forbid the delivery of electric power, from a great distance, in competition with that from coal at ordinary prices. Counting the brake horse power capacity of the motor at the point of delivery as one, the capacities of the several other elements in the electrical transmission are as follows: Step-down transformer, $1 \div 0{\cdot}90 = 1{\cdot}11$; step-up transformer, $1{\cdot}11 \div (0{\cdot}98 \times 0{\cdot}85) = 1{\cdot}38$; dynamo, $1{\cdot}38 \div 0{\cdot}95 = 1{\cdot}45$; and engine, $1{\cdot}45 \div 0{\cdot}90 = 1{\cdot}61$, as found above. The combined capacity of the dynamo and motor in terms of the brake horse power delivered by the latter is, therefore, $1{\cdot}45 + 1 = 2{\cdot}45$, and the combined capacity of the transformers in the same terms is $1{\cdot}38 + 1{\cdot}11 = 2{\cdot}49$, so that $2{\cdot}45 + 2{\cdot}49 = 4{\cdot}94$ times the rate of power delivery must be installed in capacity of electrical apparatus. A moderate price for the dynamos and motors installed with necessary attachments is $25 per horse power capacity, and on this basis their cost per brake horse power delivered at the motor shaft is $2{\cdot}45 \times 25 = 61{\cdot}25$ dollars. Allowing $10 per horse power capacity of transformers, installed, their total cost per delivered horse power at the motor shaft is $2{\cdot}49 \times 10 = 24{\cdot}90$ dollars, making the total investment for electrical equipment, apart from the line, $61{\cdot}25 + 24{\cdot}90 = 86{\cdot}15$ dollars per available horse power at the point of use or center of distribution. But the engine at the generating plant is shown above to require a capacity 1·61 times that necessary if it is located where the power is used or distributed to local lines, and the investment in steam plant is, therefore, increased 61 per cent to make up for losses in the electrical transmission. A fair price for a first-class steam power plant may be taken at $60 per brake horse power capacity, exclusive of buildings, making the value of 0·61 horse power capacity $0{\cdot}61 \times 60 = 36{\cdot}60$ dollars. The total additional investment for machinery equipment in a long distance electric transmission system, over that for a local plant, making no charge for line conductors or buildings, is $86{\cdot}15 + 36{\cdot}60 = 122\ 75$ dollars per each horse power delivery capacity at the receiving station. To compensate for this great increase of investment, there is a yearly saving of 5·22 dollars per delivered horse power. Assuming the very low figure of 16 per cent on the investment, to cover depreciation, repairs, insurance, taxes, and interest, makes the annual charge for these items $122{\cdot}75 \times 0{\cdot}16 = 19{\cdot}64$ dollars for each horse power delivered at the point of use or distribution. As the amount saved in the value of coal consumed is only 5·22 dollars per delivered horse power, the yearly outlay of 19·64 is nearly four times the saving.

This comparison is very favorable to the transmission system, because no charge is made for the additional buildings necessary with it or for the line. It should also be noted that, while the labor of operation for the generating and receiving stations and the care of the line will no doubt require more expense than the labor of operation in a steam plant at the place of use, no charge has been made for this increase. As the total cost per brake horse power in a first-class steam plant, using a fair grade of steam coal at $3 per ton, about its cost in many cities, was found to be only 11·25 dollars per year, the extra expense resulting from the equipment for long distance transmission from free fuel is $19{\cdot}64 - 11{\cdot}25 = 8{\cdot}39$ dollars per delivered horse power per year. That is, if absolutely free fuel could be had at a point 100 miles from some of our great cities, the electric transmission of steam generated power from this fuel to the cities would involve a yearly loss per delivered horse power of more than 8·39 dollars. So much for long distance transmission from the coal mines to great cities.

THE CHEMISTRY OF SOOT.

The impression generally prevails that soot is simply carbon, but although carbon is its chief constituent, there are present many other elements among which are hydrogen and nitrogen. Soot may be considered as an impure hydrocarbon, containing a very large proportion of carbon relatively to the amount of hydrogen. The smell of soot suggests ammoniacal compounds, and The London Lancet states that a recent analysis has shown that soot contains no less than 7·4 per cent of ammonium salts. This fact amply accounts for the value placed on soot for agricultural purposes. Soot on burning in a confined area, as in a chimney on fire, evolves a characteristically persistent and nauseous smell. This characteristic is probably due to the presence of nitrogenous organic compounds.

PARIS EXPOSITION NOTES.

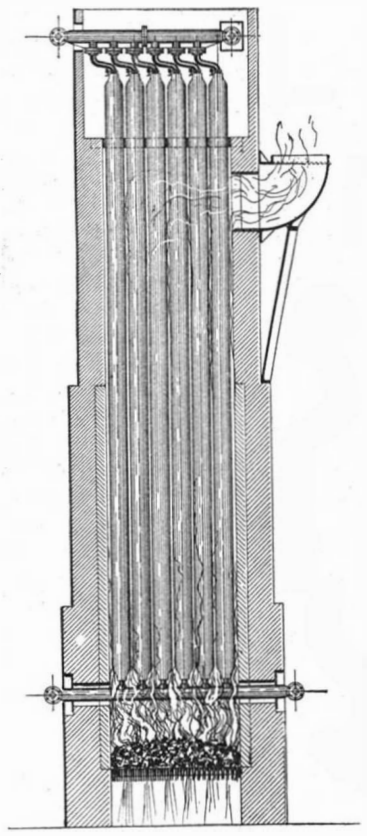
The United States Publishers' Building, which has been erected in the grounds adjoining the main buildings of the Esplanade des Invalides, contains a number of exhibits which characterize the printing and other industries of this country. The building itself presents a handsome exterior; it is of square form, and the different facades are constructed of a series of arches resting upon columns. Two doors at each end give access to the interior. A number of exhibits are grouped in the center, surrounded by a passageway, leaving space for a considerable number of exhibits around the walls. The center is occupied by the Publishers' Headquarters, containing a number of desks and chairs for the use of publishers and others; the building is under the immediate charge of Mr. Charles Simms, Assistant Director of the Liberal Arts Section; Mr. A. S. Capehart is Director of this department. Nearby is the installation of The New York Times, which prints a Paris edition on the large Goss printing press, driven by an electric motor in the basement; a model printing office is shown in actual operation, the most interesting feature of which is the series of Morgenthaler linotype machines; there are five of these in actual operation, each being driven by an electric motor mounted directly upon the machine. To the right of the entrance is the exhibit of the Mutual Life Insurance Company of New York; the cases are finished in hard wood and ornamented with reliefs and statuary; the walls are lined with framed charts showing either by figures or graphically the different statistics relative to insurance and kindred subjects, with charts showing the growth of the United States in its various resources. Near it is the exhibit of the Equitable Life Insurance Company, which also shows a number of charts, besides photographs of its various office buildings. A number of typewriters, including the Yost, Remington, Smith Premier and Century, are shown in actual operation. A number of printing presses are also shown, most of which are running; among these are the Campbell, Babcock, the Mickle, which prints in colors, and others. Among the phonographs the American graphophone and the Columbia Phonograph Companies are represented, with a number of machines. The United States Express Company has an exhibit showing the system by a number of photographs or charts. Outside the main building is a model stereotyping pavilion, containing the melting furnaces, presses and all the necessary appliances. Another small building contains the reading room; most of the principal American newspapers are on file, and the cases contain bound volumes of illustrated journals. All of the SCIENTIFIC AMERICAN publications are to be found here.

EXPERIMENTS WITH X-RAYS IN ELECTROSTATIC FIELD.

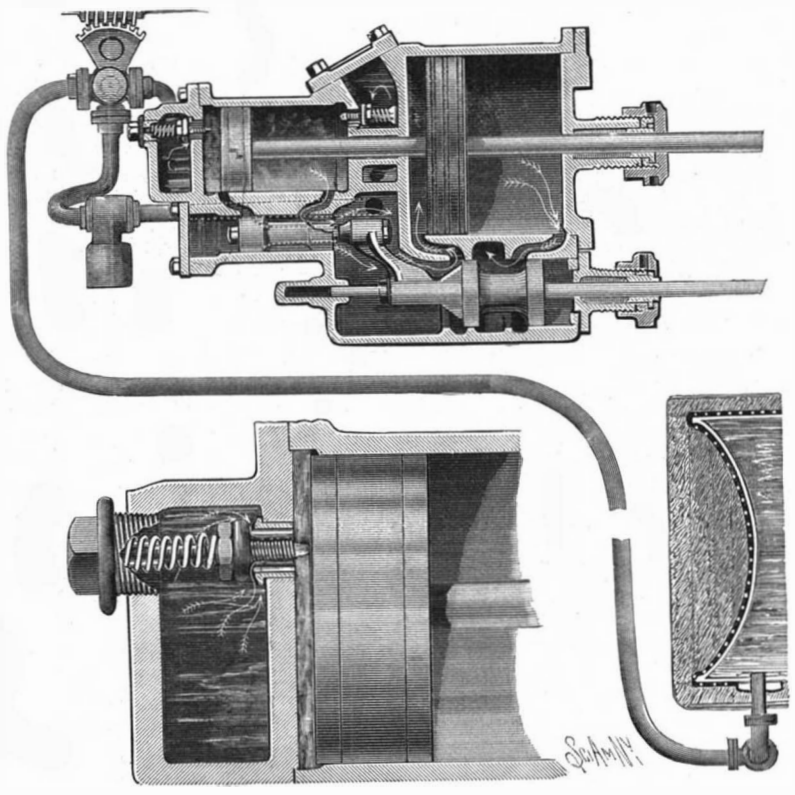
The well-known fact that light movable bodies, when placed in a Crookes tube, enter in movement under the action of the cathode rays, is used to support the hypothesis that these rays are formed of material particles moving with a certain velocity. Nevertheless, it is remarked that the presence of cathode rays is not necessarily connected with the production of the movements, for these are observed to commence before the rays appear, and to cease when the rarefaction is pushed to a certain point, even though the cathode rays are still very intense. It is more probable that the movements are due to electrostatic action, especially if they are compared with those which have been studied by Groety in the case of Roentgen rays. This experimenter disposes a very light movable body, carried on the point of a needle, between the two plates of a charged condenser. In this constant field the body remains at rest, but when Roentgen rays are brought into the field, it enters into rotation, which lasts as long as the rays continue to act. With condensers of small dimensions and a movable arrangement formed by two disks of coppor foil united by an insulating cross-piece, the direction of rotation is found to change with the direction of the electrostatic field. The position of the tube emitting the rays also affects the sense of rotation. The two plates of the condenser are not indispensable in the experiment; they may be replaced by a small sphere, or even suppressed altogether, and the vanes placed in the air in the neighborhood of a Crookes tube. The rotation is not a direct effect of the Roentgen rays, for it ceases when a sheet of ebonite or aluminium is placed between the tube and vanes, the rays still passing through this screen.

SUPER-HEATED WATER MOTOR FOR RAILROAD TRACTION.

We present illustrations of a standard railroad car now undergoing trials on the New York and Putnam Railway, which is equipped with a motor that is an interesting development of the class of engines operated by super-heated water. In the earlier systems, the storage tank was charged with water at a temperature corresponding to a pressure of several hundred pounds to the square inch, the steam from this water being utilized in the cylinders of the motor in the same manner as steam from the locomotive boiler is expanded down in the locomotive cylinders. The operation of those motors was based upon the laws of temperature and pressure which govern the vaporization of liquids, and as the steam which forms at the top of the storage tank is drawn off to the cylinders, the water in the tank boils at the lower pressure, producing more steam to supply the loss. The reduction of the temperature and pressure proceeds until the pressure falls to a point at which it is not available for use in the motor, when the tank has to be blown off and recharged.



STEAM GENERATOR FOR SUPPLYING WATER AT 700 POUNDS PRESSURE.



SECTIONAL VIEW OF HOT WATER TANK AND COMPOUND CYLINDER.

In the operation of the earlier storage motors it was found that the number of heat-units that was actually available in the cylinders was considerably smaller than had been anticipated. Indeed, it was proved that when the pressure had been run down to about half its original amount, three-quarters of the original heat-units still remained in the reservoir, and that something like nine-tenths of the water remained. It was found that only about one-ninth of the total energy contained in the heated water of the tank was available for useful work in the cylinders.

A few years ago it occurred to Mr. W. E. Prall that more economical results could be secured by withdrawing the heat from the tank, not in the form of steam, but of water, and allowing the hot water thus abstracted to give up its heat within the cylinders of the engine itself. In certain experiments carried out at Washington, D C., in 1888, it was found that practical tests confirmed the soundness of his theories. The motors which now are being tried upon the Putnam Railway cars are the first attempt to apply these theories to the operation of a standard railroad.

The advantages of taking water from the bottom of a storage reservoir, instead of taking steam from the top, are indicated by a comparison of the conditions which will exist in each system.

The reservoir or storage tank is in either case filled with water at a certain temperature and pressure. It is covered by non-conducting material so that there will be very little loss of heat by radiation.

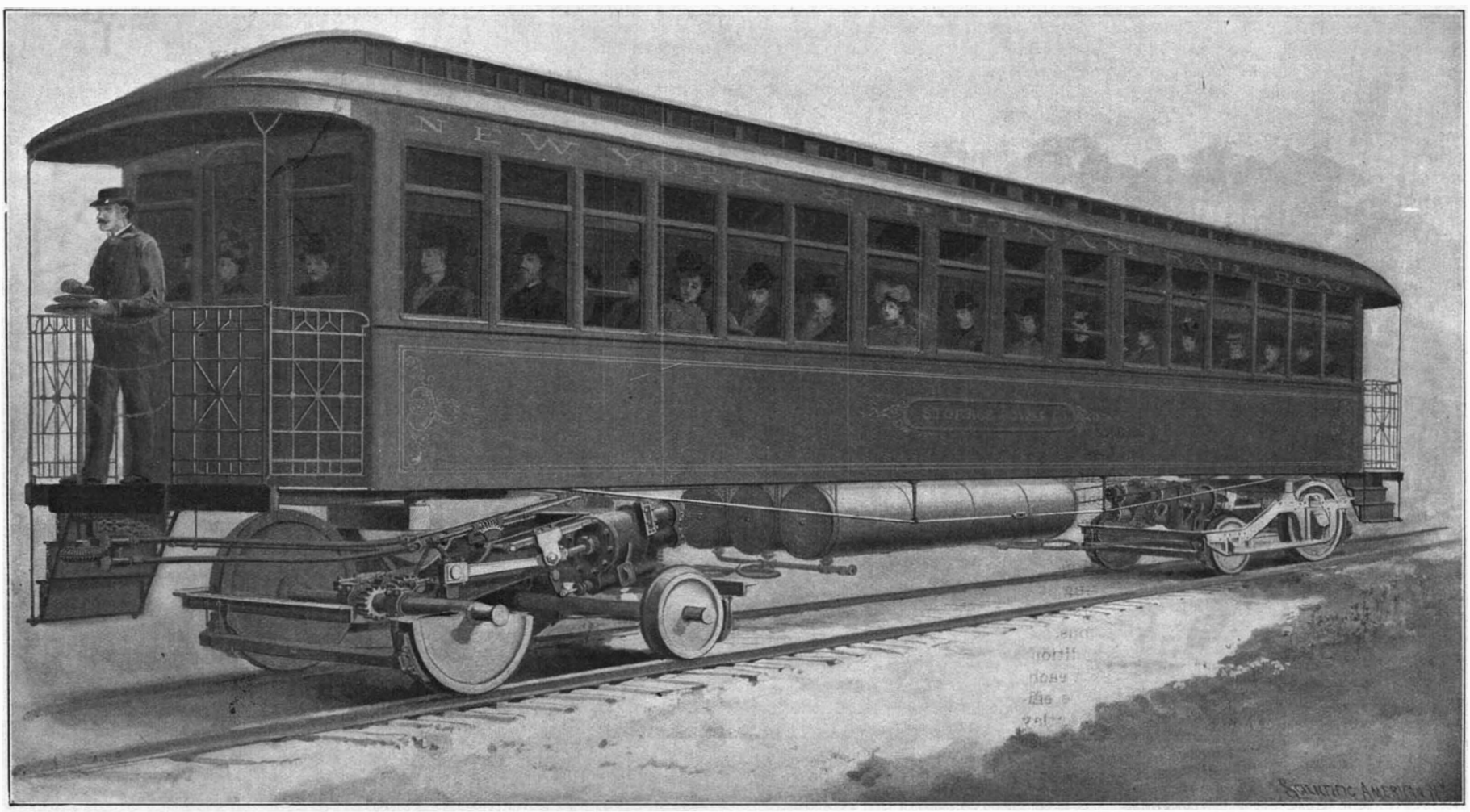
Steam drawn from the top of such a reservoir must have been developed by the vaporization of a part of the stored water; and as successive volumes of steam are withdrawn there will be successive conversions of water into steam.

When a definite weight of water is converted into steam, the resulting volume of steam must hold in itself more heat than was contained in the volume of water which was actually converted into steam. In the case of a boiler with fire burning under it, this additional heat may be supplied by the fire; but when steam is drawn from the top of a reservoir of heated water with no extraneous supply of heat, this required heat for the production of steam will be abstracted from the stored water. The temperature of the stored water will be correspondingly reduced and every successive withdrawal of a volume of steam and every consequent conversion of water into steam inside the reservoir further reduces the temperature of the water still remaining. Even when beginning with high temperature and pressure, the water cools so rapidly under these conditions as to be very soon at too low a temperature to permit the development of steam. The rate of reduction from a certain pressure and temperature may be readily determined.

The processes and conditions when taking water from the bottom of a similar reservoir are quite different.

The first step is the withdrawal of a certain volume of the heated water; but none of this withdrawn water is expanded into steam inside the reservoir. The conversion occurs in the cylinder, where a portion of the water becomes steam and the other portion, cooled by the abstraction of heat as above explained, is thrown away. None of the cool water is returned to the reservoir. The volume of water taken from the reservoir at each withdrawal is small, and the only steam in the reservoir will be that which will occupy the space left vacant by the abstraction of the water. This volume is very much less than the volume of steam taken out at each withdrawal when, as in the first instance, steam and not water is abstracted. The only cooling process is, therefore, that due to the development of the very small amount of steam to fill the void—and as the temperature and pressure under these circumstances remain high, substantially all the water may be taken out of the reservoir at the bottom leaving still a residue of steam at high pressure.

The mechanical features of the system which is now undergoing test, are shown clearly in the accompanying drawings. The generator is a modification of the water-tube boiler, and is composed of a nest of tubes coupled into manifolds at the top and bottom. The present working pressure is 700 pounds to the square inch. From the generator, water is drawn off into three carefully insulated storage tanks, carried beneath the car, whose total capacity is 7,000 pounds. The water is led from the bottom of the tanks to two water chambers, which are arranged at each end of the high-pressure cylinder, as shown in the accompanying section. From these chambers it is fed into the cylinder through three Tappet valves, each of which has a screw and nut adjustment by which the amount of feed may be regulated. As the piston travels through its strokes, the water, under the decreasing pressure, continually flashes into steam. From the high-pressure cylinder the steam, and that portion of the water which has not been evaporated, pass out through large ports on the bottom of the cylinder, and the water is drained off through suitable valves which are located



SUPER-HEATED WATER MOTOR, SHOWING ARRANGEMENT OF TANKS AND COMPOUND ENGINES.

in the lower face of the valve-chest. The exhaust steam from the high-pressure cylinder is conducted in the ordinary way to the low-pressure cylinder, from which it is finally exhausted to the atmosphere.

The valves which control the admission of hot water to the motors are so constructed that water may be fed directly to both cylinders, when it is desired to exert an extra effort in starting the car, a by-pass arrangement being used which is somewhat similar to that adopted in compound locomotives of the usual type. The method of mounting the cylinders upon the trucks is clearly shown in the accompanying engravings. The Stephenson valve motion is used, and a common valve stem does duty for the piston slide valve of each cylinder.

The car may be operated from both the front and the rear platforms, the starting, stopping or reversing of the engines and putting on the brakes being performed by means of three superimposed hand-wheels, arranged just above the dashboard of the car. One of these wheels connects through a central shaft with a pair of miter wheels, one of which is keyed to the vertical shaft, and the other attached to the outer end of a length of flexible shafting. The other end of the flexible shaft is looped to a rod, on which is a worm that engages a segment of a worm wheel, which in its turn operates the reversing lever. A second hand wheel operates through a similar arrangement of miter wheels, flexible shafting, worm and worm wheel segment upon the throttle, the details of the throttle and worm wheel segment being shown in the accompanying sectional view of the cylinders. The third hand-wheel operates a brake and gear of usual pattern. Each truck is equipped with two compound engines which are coupled upon a common crankshaft, with the crank set at 90°. A pinion at the crankshaft engages a smaller pinion on the shaft of the driving wheel axle. It is estimated that with the three tanks charged with water at 700 pounds pressure, at a corresponding temperature of 500°, the car will be capable of running for forty miles at a speed of from thirty to forty miles an hour.

Telephone in Sweden.

Sweden is the country in which the use of the telephone is the most widely extended. The first long-distance line was established by the State in 1889, between Stockholm and Gothenburg, 300 miles distance. Since then the number of lines has been constantly increasing, and at the end of 1898 the longest distance covered was 2,000 miles, between Hoparando and Ystod. The progress is shown by the fact that in 1890 there were 7,680 miles of lines, 126 stations, and 4,950 instruments; in 1897 this had increased to 45,180 miles, 734 stations, and 32,890 instruments. The rapid development of the State telephone lines has not prevented the extension of the systems installed and maintained by private companies, as will be observed by the fact that in 1896 there were 25,200 miles of lines, 387 stations, and 22,500 instruments. The subscription rates asked on the State lines rarely exceed $14, but on some lines reach $25; in other cases the rates are as low as $2.80. The largest of the private companies is the General Telephone Company, of Stockholm, whose system in the city and suburbs covers a radius of 43 miles. The competition with the government lines has brought about a reduction of rates, which accounts for the extensive use of the telephone in Stockholm, and the region has no less than 30,000 telephone posts.

UNITED STATES LEGATION AT PEKING.

A New Photographic Plate.

An invention has recently been patented in England for a photographic plate or film which has the developer, or the developer and fixer on the plate, so that it is only necessary to place it in water to obtain a developed, or a developed and fixed negative. The developer is applied to the plate in dry form and is then protected by an air-tight covering, the chemical not becoming active until the plate is put into a bath of water. The combined developing and fixing methods give the best results. The ingredients are mixed with a strong solution of sugar or dextrine. The solution may be applied to the back of the plate and then protected with paper or soluble gelatine, or it may be coated upon a paper backing sheath or envelop which protects the plate. The material can also be applied to the back of the film and can be cut up with the film for development. The process of development merely consists in placing the plate in water, which softens the covering and dissolves the developer. A similar process has been applied to printing papers by the inventors.

A Traveling Central Station.

According to the Technische Revue, there is in use on the French railroads a traveling central station consisting of a railway car bearing a dynamo and a petroleum motor, the latter serving for driving the former. One of the axles of the car is fitted with an electro-motor, which receives its current from the dynamo, so that the auto-car can go wherever there is work to be done. There the current generated by the dynamo is used either for running machines or for illumination. It suffices for feeding four to six arc lamps or thirty to forty incandescent lamps. This "electric power house" has been found especially valuable for working in railroad tunnels.

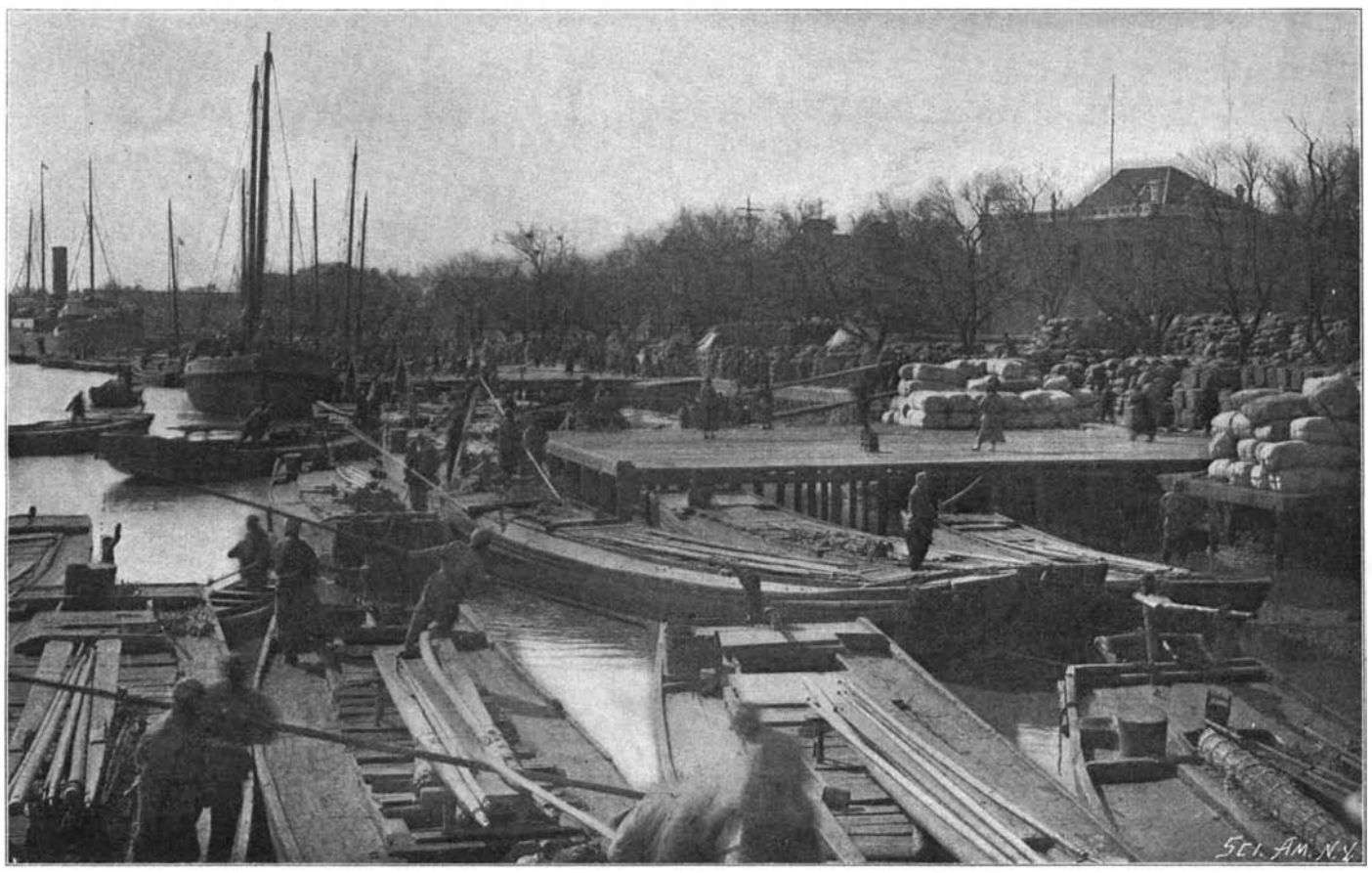
PROBLEMS OF THE CHINESE CAMPAIGN.

BY WALDON FAWCETT.

The military campaign in China will encounter graver engineering problems, particularly in connection with the maintenance of an adequate transport system, than have appeared in any similar operations in recent years.

In the first place, the water transportation of troops, animals, and supplies to the base of operations is a work considerably more arduous than was the corresponding task in either the Boer or the Spanish-American war. Russia, through the use of the new Trans-Siberian Railway, has perhaps the best means of access to the scene of conflict; but the United States, Great Britain, Germany, and all the other nations participating in the movement, find it necessary to transport nearly all of their troops and practically all supplies distances equal to from one-third to one-half the circumference of the earth.

In so far as this phase of the case is concerned, the experience of the quatermasters' departments of the American and British armies in the recent wars is of great value. Not only has a knowledge of the economical conduct of a transport system been acquired, but the troopships, fitted up to meet the emergencies of the past few years and remaining in service, formed the nucleus of a fleet which, under less favorable circumstances, would have required months for assemblage. It early became apparent that, owing to the length of the voyage to be made, it would be necessary to provide a good sized fleet of transports; and the various nations, therefore, lost no time in chartering practically all the vessels on the Pacific available for such purposes.



WHARVES AT TIEN-TSIN—BASE OF SUPPLIES OF AMERICAN ARMY.

Perhaps a word should be said with reference to the transport service of the United States War Department upon the Western ocean, since it would appear to be nearly model in almost all respects. The fleet now in use for service between this country, China, and the Philippines consists of thirty-four vessels, aggregating nearly 135,000 tons burden. Of this number fourteen vessels of 60,500 aggregate tonnage are owned outright by the government and are regularly in its service, the remaining score of steamers, the tonnage of which is in excess of 75,000 tons, are chartered from private firms and individuals, and more than half of them

have been secured since the outbreak of trouble in China. For these craft the Transportation Bureau of the Quartermaster-General's Department pays about $11,000 per month, or in the neighborhood of $550 per day. All of the transports which are owned by the government and which, between original purchase price and the outlay for refitting, have cost $10,000,000, are employed in carrying troops; but all save two of the chartered steamers are used either as freight ships or for the transportation of animals.

The Navy Department in its preparations has been confronted with almost as many difficulties as have the army officers. There is no satisfactory naval base within a reasonable distance from the scene of operations. Manila is more than two thousand miles from Taku; and in case of a naval war the ordinary Chinese ports would be closed. About the only solution possible is a joint use of the coaling-station at Chefoo, with the British, or of the naval base at Port Arthur, with the Russians.

In a land campaign, much of which may have to be carried on in the dead of winter, with the thermometer below the zero mark, fuel will naturally be a primary requisite, but it is planned to resort to the scheme which proved successful in the Spanish-American war when the nation suffered from the same lack of coaling stations which now threatens to embarrass it. A fleet of colliers was then pressed into service to carry coal. Fortunately, a number of these vessels are still in the possession of the War and Navy Departments. The fierce competition for tonnage on the Pacific for war uses has, however, had its effect and the government is paying $9 per ton for the transportation of fuel to the Orient, whereas a few months ago the service was performed for $7 per ton.

In anticipation of a further advance in the freight rates to a practically prohibitive point the government has fitted out the colliers which were purchased during the Spanish-American war, and which have since been out of commission. The same plan has been followed with water-ships, disinfecting barges and other adjuncts of warfare upon the sea. There are about twenty vessels in the collier fleet.

All the reports thus far received by the government emphasize the difficulties of unloading pack and cavalry animals and supplies at Taku. The necessity for a change of the base of operations from Nagasaki to Taku consumed no little time; and some confusion has doubtless been induced by the strenuous effort to land every ton of fuel and supplies possible, owing to the fact that the rivers and bays in north China freeze as early as November 1.

Although the authorities at Washington early decided to make use of the Pei-Ho River for conveying supplies to the successive camps of the American forces on their march to Peking and authorized Gen. Chaffee to purchase all the steam launches, drawing three feet of water or less, for the transportation of both troops and supplies, the value of this waterway as an avenue of communication is at best uncertain. Above Tien-Tsin it is navigable only for light draught vessels; and the windings are so numerous and the bends so sharp that hawsers must be resorted to continually in order to facilitate the progress of the larger craft. Water transport via this river was, however, employed by the Anglo-French force in 1860, and the allies found at Taku and Tien-Tsin a large number of specially constructed junks and light draught tugs which have proven well adapted for the purpose at hand.

The roads of China vary greatly in character, and the eight-six mile stretch between Tien-Tsin and Peking which constitutes the pathway of the allies is in some respects one of the best in the land. It follows the Pei-Ho River closely, and during the rainy season, which does not end until well into September, is nearly impassible in places, a circumstance which is by no means strange when it is remembered that the rainfall frequently exceeds ten inches per day. With the rainy season past, travelers on the road have the terrific dust storms to bear. Much of the country is open; the soil is sandy, and the heavy traffic over the thoroughfare grinds the light soil into a fine dust that fills nose and eyes and mouth, and at times almost prevents travel.

The whole tract of country between the seacoast and the Chinese capital is usually flooded during the autumn, and this year the usual inundations were greatly increased by the breaking of dikes on the Pei-Ho River by natives who sought to impede the progress of the invading army. This circumstance has entailed no little inconvenience upon the allied forces, since it not only obliterated many roads and destroyed bridges, but destroyed a considerable portion of the crops in the territory between Tien-Tsin and Peking, a tract which has been denominated one vast truck garden, and which, under ordinary conditions, would have afforded ample sustenance for an army of almost any size.

It was, unquestionably, the wretched Chinese roads which forced Admiral Seymour, the British commander, to abandon his effort to relieve Peking before the middle of the summer. His soldiers might have overcome the resistance which they encountered had they not been compelled to put the road along which they were advancing in passable condition. The first sections of the roads, moreover, are much the best, being nearly level; whereas the highway, as it approaches Peking, winds among hills and is frequently cut between banks from ten to twenty feet high. Here careful scouting is necessary, owing to the excellent opportunities presented for ambuscades.

According to the best informed military authorities who have visited the Chinese capital, the defenses of Peking have been greatly overestimated. The famous wall which surrounds the city is of great height and thickness; but it is composed mainly of earth dug from the adjacent moat, and this mass, although faced with brick and stone, would prove by no means impregnable to modern engines of war. The defenses of the sixteen gateways are inadequate, and at some places painted cannon have been utilized to give a semblance of strength.

The great danger to the health of the foreign troops is found in the radical changes in temperature. From the intense heat of the summer there is a quick transition to the dampness of the rainy season. This, too, is followed by a period of cold nights, and finally by the winter season of bitter cold days and nights. Had not precautions been taken the drinking water would have constituted a source of great danger to the health of the soldiery; but the United States government at the outset expended the sum of $14,000 in the purchase of a distilling and sterilizing plant especially for use in China, which plant has a capacity of 32,000 gallons of pure water per day, so that the wants of the soldiers of this nation at least are well provided for.

The arrangements are the best possible under the circumstances. Owing to the fact that China has never signed the Geneva treaty guaranteeing the consideration of Red Cross nurses as non-combatants, it is unlikely that any female nurses will be detailed for duty in the interior; but the United States hospital ships "Solace" and "Relief," the hospital ship "Maine" fitted out in England for use in South Africa, and other similar craft are stationed at Taku and other ports to care for the wounded. Each of these vessels can accommodate from three hundred to four hundred patients at a time.

The railway and telegraph systems of China are not likely to play a very important part in the present campaign. If hostilities are prolonged to any extent they will almost certainly be destroyed beyond all hope of speedy repair. There are only 350 miles of railroad in the Empire.

Prior to their destruction during the past summer, telegraph lines connected Peking with the capitals of practically all of the provinces and extended far into the dependencies, connecting also with the ocean cables and with the Russian Trans-Siberian telegraph lines. The total length of the lines, according to statistics that were compiled but a few months ago, exceeded four thousand miles.

The Present Position of Roentgen-Ray Work.

At the recent meeting of the Roentgen Society, Mr. Wilson Noble, in the course of his presidential address, said no very striking discovery with regard to the rays had to be recorded, but a steady improvement had taken place in general practice. It was now possible to shorten exposures and to get far better definition, both in sciagrams and on the screen. In the latter case there was much greater clearness, and, what was of even more importance, an absolutely steady image. It was also possible to localize foreign bodies with certainty, and the importance of stereoscopic radioscopy, seeing objects in relief on the screen, was an accomplished fact. There were many things difficult to see, or, at all events, to distinguish with certainty, when seen as a flat surface, but which came out with wonderful clearness when seen in relief. One had only to look at an ordinary stereoscopic slide, first without and then with a stereoscope, to appreciate this. More particularly was this the case with objects showing but little contrast and ill-defined; such, for instance, as the early patches of tuberculosis in the lung. He could not but think that the diagnosis of this disease would be enormously facilitated when sterescopic radiography became general. Many minor improvements had been brought before the society during the past year. One noticeable feature of the present practice was the adoption of the influence machine by many workers. It was too soon to say whether that machine would ever supersede the coil. In South Africa the rays had rendered admirable service. It was a fortunate circumstance that the work for which they were most wanted on the battlefield—i. e., for the localization of foreign bodies—was the easiest to perform, for the employment of the rays anywhere than at a well appointed base hospital was accompanied with enormous difficulty. The number of cases constantly coming in, the necessity for hurrying through them, and the constant impossibility of keeping the tube in good working condition, the difficulty of charging the accumulators, and many other serious inconveniences, made it a marvel how any satisfactory work could be done.—British Journal of Photography.

Science Notes.

Formosa produces by far the greatest quantity of camphor. The annual output amounts to between six million and seven million pounds, while the Japanese annual production is about three hundred thousand, and that of China two hundred and twenty thousand pounds.

Dr. S. Adolph Knopf has won a prize of 4,000 marks offered by the Tuberculosis Congress for the best essay on the subject "How to Fight Tuberculosis as a Disease of the Masses." Eighty-one essays were offered in competition. The award was made by a committee composed of several of the leading German physicians and two or three State dignitaries.

A letter has been published in Moscow from Sven Anders Hedin, a traveler, in which he mentions an excursion into Thibet in a direction never before attempted by Europeans. He succeeded in reaching Lake Lobnor, on the shores of which he discovered the remains of an ancient city. The ruins were magnificent and were intersected by broad roads.

The ice habit is making rapid progress in Great Britain largely owing to the calls of Americans. To-day all first class establishments put ice upon the tables in small tubs and guests pick out as much as they desire with ice tongs. Though few saloons and restaurants have refrigerators, many private houses are now provided with them. The consumption of ice would be much greater if regular companies distributed it, but the business is now largely in the hands of fishmongers. The yearly consumption of ice in England is 450,000 tons and in London 160,000 tons. Much of the ice is brought from Norway and a considerable quantity is manufactured.

London is at last to have a complete ambulance service. There is no place in the world where it is so much needed. The Metropolitan corps of the St. John Ambulance Brigade does excellent work, but their chief surgeon, Mr. S. Osborn, recommends that the service should be under the control of the London County Council. His idea is to graft an ambulance system for London on to the Metropolitan Fire Brigade, by whom it can be easily horsed, housed and supplied with alarm calls. The London Fire Department does not have any too many horses now for prompt responding to calls, and it would necessitate an increase of the number of houses if the new scheme is adopted.

It has for a long time been supposed that the mongoose was immune to snake bite, but an official report of R. H. Elliot states that the creature is not immune in the fullest sense of the expression, as it may succumb to a snake bite, if sufficiently severe, the same as any other animal. His researches show, however, that the mongoose enjoys a partial and comparative immunity from snake poison. That is to say, a mongoose requires from ten to twenty-five times as much cobra venom to kill it as a rabbit does, and from five to ten times as much as a dog. The mongoose was introduced into Guadeloupe and Barbadoes twenty-five years ago, and in this period there has been a very appreciable reduction of the animal's resistance to snake venom.

M. Pietro Pellegrini, an Italian scientist, has lately published the results of his researches upon mushrooms of the poisonous variety, of which the following resumé may be given: The poison of mushrooms dissolves easily in water and the aqueous extract keeps its toxic properties for a long time, these having been strongly marked at the end of eleven months. The poisonous action is not diminished by the drying of the mushrooms by heat. Mammals and birds show a great sensibility to the poison, even in feeble doses, but on the contrary it is without effect upon cold-blooded animals. The action is shown very clearly when it is injected under the skin; animals, when subjected to frequent injections of this kind, acquire a certain immunity, and the serum of these animals may be used as a remedy in cases of poisoning.

Mr. Joseph Jaubert has addressed the following note to the Académie des Sciences, relating to a halo of extraordinary appearance observed on the 22d of June at 10h. 45m., at the Observatory of Montsouris, Paris. Messrs. Besson and Dutheil observed an irised arc at the interior of the ordinary halo of 22° radius, of which the upper half was then visible. This arc appeared to belong to a circumference having the sun as a center; about three-eighths of the circumference was represented. The two observers made drawings separately, which were found to be concordant. According to one of these, the radius of the exterior halo was 17°; the second gave 17·5°. The duration of the phenomenon was about 10 minutes. From 18h. to sunset were also observed, besides the two ordinary parhelia, brilliantly colored; the summit of the halo of 22° radius crowned by a mass of white light; the halo of 46° radius, of which the whole of the upper half was visible at 18h. 20m.; and finally a luminous column which was already perceptible at 19h. and which acquired at 19h. 30m. a length of nearly 20°. It disappeared before sunset, on account of the thickening and alteration of the layer of cirro-stratus to which it was due.

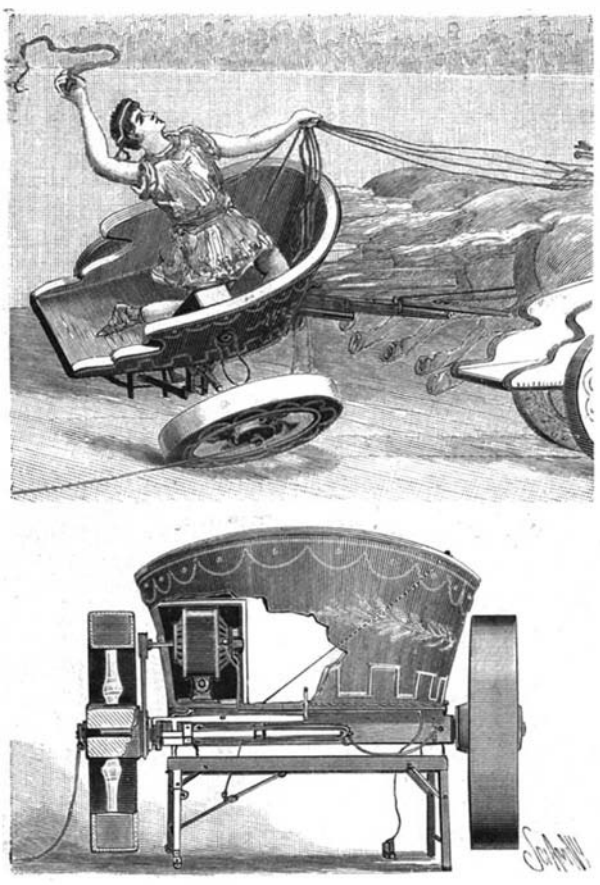
SOME STAGE EFFECTS IN "BEN HUR."

For years the public has been demanding more and more realism in plays. Managers have found great difficulty in satisfying this demand, owing to the time required to set elaborate scenery. The public dislikes long waits, and more than once a play or opera has proved a failure on this account; but after one has seen the production of an elaborate play from behind the scenes, he will never again be impatient at the length of the *entr'acte*. The only wonder is that the elaborate setting can be gotten ready in the five to fifteen minutes between the falling of the curtain at the close of one act and the raising of the curtain at the beginning of the next act. An excellent piece of work of this kind is shown in "Ben Hur," in which the scenery is shifted, in the dark, in from five to thirty seconds.

"Ben Hur: A Tale of Christ," by Gen. Lew Wallace, was first published in 1880, and has attained a wider sale than probably any other American work of fiction, with the exception of "Uncle Tom's Cabin." Notwithstanding this fact, twenty years elapsed before it was dramatized. We present some illustrations of scenes from "Ben Hur," as played at the Broadway Theater, New York. They represent some of the latest phases of good stage mechanism, and the chariot-race scene is probably unrivaled. Our readers are doubtless familiar with the story. It will be remembered that Ben Hur, the hero of the play, by accident dislodges a tile from the roof of the palace of Hur, in Jerusalem. The tile falls upon Valerius Gratus, the new Procurator of Judea, injuring him. The young prince is betrayed by Messala, his one-time friend, and he is hurried away to the galleys, while his family are thrown into prison and their possessions confiscated. The second act opens with the interior of the cabin of a Roman galley, or, rather, trireme. In the center sits the tribune, Arrius, on a raised dais, while in front of him sits the sailor whose office it is to strike a sounding-board with gavels, keeping time for the rowers. Along the sides of the cabin are rows of benches, which are really a succession of rising banks, and here are the galley slaves, who are each pulling at an immense oar. The tribune is impressed with the appearance of young Ben Hur, who is now a galley slave, and he gives orders that when they go into battle Ben Hur shall not, like the other galley slaves, be chained; for in case of the boat sinking, the slaves would all be drowned. Then comes an action with the pirates, in which the galley is sunk. The crash and grinding of the timbers are admirably rendered by what is known in stage parlance as a "crash" machine. The lights are then turned out and in an instant they are lighted again, showing the wreck scene, which is reproduced in our upper engraving. The side scenes fold up instantly when the change is made and drop to the floor. The rowers' benches are pushed out of the way and the borders and back-drop are raised from view. The galley slaves with their oars drop to the floor, and the men from the rear draw forward a painted cloth which represents the sea; it is secured to a batten and is laid down just back of the footlights. Men now step forward carrying the cloth which covers the raft, which rests upon the tribune's seat. The back-drop scene was in place before the back drop of the galley was raised. It will be remembered that the galley slaves are lying upon the floor and they now throw up and down the canvas cloth, producing a most realistic imitation of waves. They are assisted by a number of men in the wings, who pull the cloth in unison. The raft itself consists of two cradles, which are each so hinged that a rocking motion is given in two directions. This is done by Ben Hur and Arrius themselves. The raft is in position in the previous scene, but is not allowed to move, being held by pins, which are removed by those behind. With an electrical sun and proper electrical effects, the scene is very realistic, and is interesting as showing how simply a good stage effect can be produced.

It will not be necessary to rehearse the subsequent adventures of Ben Hur, but in his wanderings he comes across his enemy, Messala, and decides to humble him and ruin him by a chariot race in the circus at Antioch, and this scene is one of the most realistic ever produced. It is a combination of several effects, some of them old and many of them entirely new. The new effects were invented by Mr. Claude L. Hagen, of the firm of McDonald & Hagen, New York city, who is also the master machinist of this splendid production of "Ben Hur." When first introduced upon the stage, the horse race was a decided novelty, and it is doubtful if any stage illusion is more ingenious. The two principal plays in which the horse race has been used are Neil Burgess' production of the popular play "The Country Fair" and the French play presented in Paris called "Paris Port de Mer." In both of these plays three horses, each ridden by a jockey, race upon the stage without going out of sight of the spectators. We have in these plays an illusion true to nature; the horses, appearing to be free from all restraint, are really galloping, the ground disappearing under their feet and the landscape as well as the fences fly past in the direction contrary to the forward motion of the horse. This is accomplished by means of a treadmill, which the horses themselves actuate. In "Ben Hur," many radical improvements have been introduced, even in this part of the performance. Reference to our engravings will give an idea of the mechanism.

A large part of the illusion depends upon the background, which gives the idea of positive motion, and the one shown in our engraving, invented by Mr. Hagen, is very novel. It embodies means for mounting and driving traveling aprons at the rear and sides of the stage, so as to prevent any break in the scene, and this, of course, gives the audience the impression of change of scenery, as in the illusion the spectator follows the racing horses. At the rear of the stage is an endless apron, flanked on each side by smaller end less aprons, each of which is complete in itself, but are operated in unison. When not in use the side aprons may be folded back against the rear apron; but while the scene is being "set" for the chariot race they are extended to the position indicated in our engraving. Upon these aprons are painted representations of the background of the scene; in this case representing the antique circus at Antioch filled with spectators. The mechanism will be understood by reference to our engraving. Directly below the chariots will be seen the electric motor which actuates all three aprons of the panorama. It is a five-horse power Lundell motor, and is operated at the proper time by the assistant, who stands at the switchboard and who receives the signal of the stage manager by a flash of a colored electric lamp. The motor is started manually. A twisted belt imparts motion to a vertical shaft upon which are three pulleys, one to receive the power from



TRICK CHARIOT IN "BEN HUR."

the countershaft and the others to transmit the power to the two ends to vertical shafts, which each carry a cylindrical drum, around which the aprons are passed. Their rotation causes the apron to travel continuously, and gear-wheels are provided, as shown in our upper left-hand engraving, which impart motion to the side aprons, so that they are all driven in the same direction, and to the spectator the three aprons appear to be a continuous, unbroken scene. Notwithstanding the fact that the panorama is 96 feet wide and 25 feet high, the three panoramas are all rotated at a speed of 2,000 feet per minute by a two-horse power motor. The ease with which this enormous extent of canvas is driven is largely owing to the method of suspension, which is also shown by a small inset in our upper left-hand engraving. There is an endless track mounted rigidly on and extending between the outrigger-structures at the two ends, and upon this wheels or rollers are mounted to run on the tracks. The wheels or rollers are secured to hangers which are attached to a belt which runs around the upper portions of the drum to which the panorama apron is fastened. By these means the apron is suspended in the proper position, and it is caused to turn true around the drums without crinkling or being subjected to other distortion. The lower edges of the aprons are provided with a belt mechanism, similar to that at the top, which serves to keep the bottom edge of the apron in a proper position. These belts also serve to receive the power transmitted by the drums, which arrangement avoids straining the apron, as would be the case were the apron engaged directly with the drums. These hangers are shaped as frustums of a cone and are mounted by ball bearings on the spindles which carry them.

To make the illusion complete, Mr. Hagen has provided an exceedingly ingenious means for representing the ground, causing the chariots to appear to be actually moving over it. This illusion is effected by a number of narrow, endless canvas belts, painted in low tones to represent the ground and placed edgewise on the stage between and in front of the chariots and extending across the stage. On being driven toward the rear of the chariot it appears to the spectator that the chariots are moving over the ground. To give proper perspective to this effect the speed at which the belts are driven is gradually decreased toward the rear of the stage. Suitable gearing is provided for driving these belts, which are actuated by an independent motor shown at the right of the picture. The belts themselves are carried on pulleys which are mounted on housings which may be readily placed in position when the scene is set. For connecting the pulleys which carry the belts with the gear for driving them, couplings are provided which pass through the floor of the stage and which may be readily taken up when the chariots are removed, leaving a clear and uninterrupted stage. We now come to the chariots themselves.

The treadmills are placed immediately beneath the stage and are covered by sections of planking which are removed and carried out to the wings when the race is to take place. There are eight treadmills, one for each horse, and the horses are brought up from the stables, a few blocks away, a short time before they are needed, and they take their places with the artists and supernumeraries awaiting their cue to go upon the stage. They seem to take huge delight in the performance, and seem to know to the minute the time when they are to run. The chariots are two in number and each is supposed to be drawn by four horses, and each chariot is provided with a pole. The chariot of Ben Hur is not a trick chariot, but that of Messala is arranged to go to pieces when Ben Hur is supposed to strike his chariot, throwing him and causing him to lose the race. The chariot wheels do not rest upon the floor of the stage, but are supported upon metal yokes which are not noticed by the audience. The wheels are actuated by a small electric motor inside the body, and can be switched on by the drivers. Both chariots have these motors, and current is obtained by the aid of plugs which are inserted in the floor. The chariot of Messala is arranged so that at the critical moment when Ben Hur strikes Messala's chariot by dropping a catch, powerful springs on the axle throw the wheels off and the body of the chariot drops upon a yoke which is provided with springs. Of course, it is necessary to make one of the chariots appear to go ahead of the other. This could, of course, be managed by allowing the horses to really advance, but with four horses this might prove dangerous. The same means is accomplished by having the four treadmills and the place upon which Messala's chariot rests on an independent section of the flooring, which can be moved back a distance of 15 feet. Underneath the stage joists support this movable section and it slides directly on top of these joists. Curtains simulating the color of the stage close the aperture at both ends, so that it is not visible to the audience. At the extreme right of our engraving, behind the side of the panorama, will be seen men working at a winch. This winch winds up a wire rope which is carried over a pulley at the extreme left underneath the stage, and is connected with the entire movable section carrying Messala's chariot and horses, and three men move the whole affair back with ease and give the appearance of Ben Hur winning the race. A stop is provided so that the treadmill cannot be operated by the horses until the panorama has begun to move and the curtain is ready for operation. The horses are very securely fastened, so that there is little danger of an accident. To simulate the dust raised by the chariot wheels, a combination of powders is forced out underneath the horses' feet and behind the chariot wheels. This is accomplished by a blower in the cellar, driven by the same electric motor which actuates the belts. The dust is fed into a hopper and is blown through fourteen ducts arranged at proper intervals to produce the desired result. The "dust" is a combination of vegetable products arranged so as to imitate the dust of a road having the buoyancy of natural dust without its grit.

It requires about eight minutes to set this scene, and in that time the side panoramas are folded out into position, the sections of floors are removed, and the chariots are rolled into position and adjusted. The horses are hitched to the chariots, connections are made with the belts for giving the effect of moving ground, and the dust arrangements are put in place.

THE telegraph was first established in Japan in 1869, when a line was built between Yokohama and Tokio by English engineers. In 1873 the Government Telegraph Department was organized. In 1879 the Empire joined the International Telegraph Union. There are now 1,267 offices in Japan proper and 112 in Formosa, and there are 144,570 miles of line in service. In 1899 these lines transmitted 224,000 foreign and 15,275,623 domestic messages.

THE PARIS METROPOLITAN UNDERGROUND RAILROAD.

The opening of the first section of the Paris Metropolitan Railway, on July 19, marks an interesting event in the history of rapid transit, for certainly no city in the world has been so behindhand in transportation matters or which will so soon be adequately provided. It is true that it was possible for any one to travel by the Ceinture Railroad from one great railway station to the others, but the changes were numerous and the line did not affect the transit problem.

Paris is very closely built, and large sections of it depend entirely upon omnibuses and street railways, but for many years the service has been slow and entirely inadequate. The Parisians understood the need for some rapid system of transportation, and in 1856 a project was agitated for connecting the center of Paris with the circumference. It was not until 1871 that the authorities began to study seriously the problem. A remarkable report was issued, and the scheme, as outlined, has been followed to-day as regards the main ideas. In 1889 the need of a new line was strongly felt, and when the Exposition of 1900 was resolved upon the necessity for haste was apparent. In 1896 plans were formulated for supplying the insufficiency in transportation facilities and also to attempt to build up outlying quarters. The gage was to be of such a dimension as would insure the autonomy of the line. Electric traction was to be used. The tunnels, viaducts, etc., were to be built by the city of Paris, and other expenses were to be paid for by a concessionaire.

One condition of success of the Metropolitan seemed to be the connection of its lines with the railroad stations of Paris. Such connection would offer great advantages, as it would permit travelers to cross the city without going out of the stations, and would thus effect a great saving of time. The greatest advantage was doubtless the possibility of going from any point in the city to the different stations of the suburbs without changing cars. This argument should have caused the Municipal Council to decide upon a junction, but it had the opposite effect. The Council feared that if the Parisians had such inducements for living in the suburbs, the population would decrease, and their octroi, or municipal tax, would diminish. It also feared that the railroad companies would some day have too decisive a voice regarding the Metropolitan, and would thus become the managers after having been evicted as tenants. After having decided upon a track one meter in width, which would have altogether put an end to the project, it revised its decision and substituted the normal gage, but with this restriction, namely, that the cars should be smaller than those of the companies, and that the tunnels should be of such size that the cars of the Metropolitan could circulate only on the city system. In this way the city will always be master of the line, and the companies, if they intend to connect with the city line, will have to make their time-tables according to its wishes. This condition may become illusionary, however, for when the State gave the concession to the city, it reserved the right of letting the railroad companies make connections with each other in Paris if they found it convenient.

The Municipal Council approved the project on July 9, 1897, and on March 30, 1898, a law was promulgated making the work one of public utility. The law of April 4, 1898, authorized the city to borrow 165,000,000 francs and the modification in width required this sum to be raised to 180,000,000 francs.

Only a small section of the projected system has been completed and not all the trunk-lines and branches have been authorized.

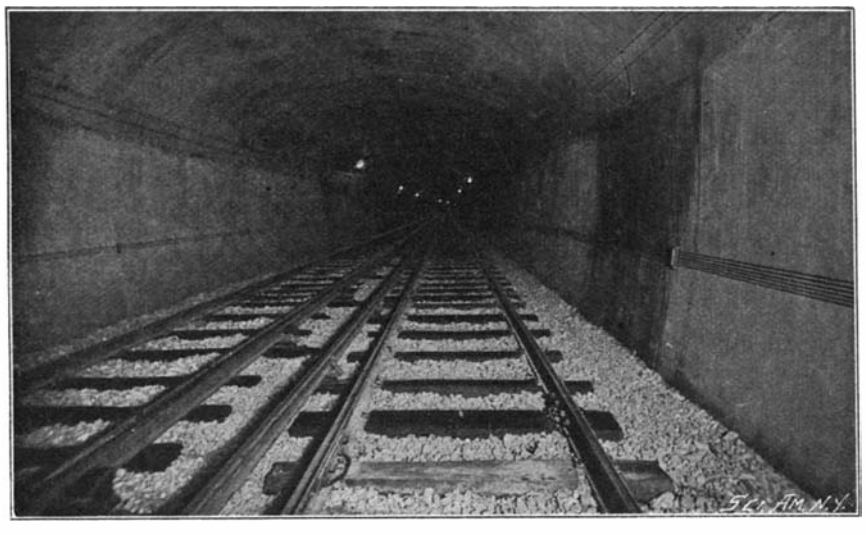
Following is a list of the lines in the order of construction: 1. From the Porte de Vincennes to the Porte Dauphine, with a connection to the Porte Maillot. 2. Circular line starting from l'Etoile and following the outside boulevards. 3. Ménilmontant to the Porte Maillot. It separates from the two preceding lines at the Rue de Constantinople and passes through the Rue de Rome, the Boulevard Haussmann, the Rues Auber, Quatre Septembre, Réaumur, Turbigo, and Temple. 4. From the Porte d'Orleans to the Porte Clignancourt. This is the north-south transverse line. 5. Boulevard de Strasbourg to Pont d'Austerlitz. It connects the Place de la Bastille to the circular line. 6. Boulevard de Vincennes to Place de l'Italie. 7. From the Place Valhubert to the Quay de Conti. 8. Palais Royal to the Place de la Danube by the Rue Lafayette. 9. From l'Opéra to Auteuil by the Place de la Concorde and the Invalides.

All the lines comprise two systems, a number of transverse lines and a circular line, with other short lines connecting them together at various points.

The part now actually finished consists of one complete line and the beginning of two other lines. The first is the main transverse east-west line, which connects the Bois de Boulogne with the Bois de Vincennes. It passes under the avenues of the Grande-Armée and the Champs Elysées, follows the Rue de Rivoli and the Boulevard Diderot, and runs parallel with the Vincennes road till it reaches the gate of the same name. Of the two other lines in course of construction, the most important is that running from Place de l'Etoil to the Trocadéro. This has a junction with the first-mentioned line, so that passengers from the Bastille and Rue de Rivoli can take the train directly for the Trocadéro. The third line starts at the Porte Dauphine, and runs under Avenues Bugeaud and Victor Hugo to Place l'Etoile. It is the beginning of the great circular railway. The Place de l'Etoile is a kind of central station. Under its roadway the tracks branch out in all directions.

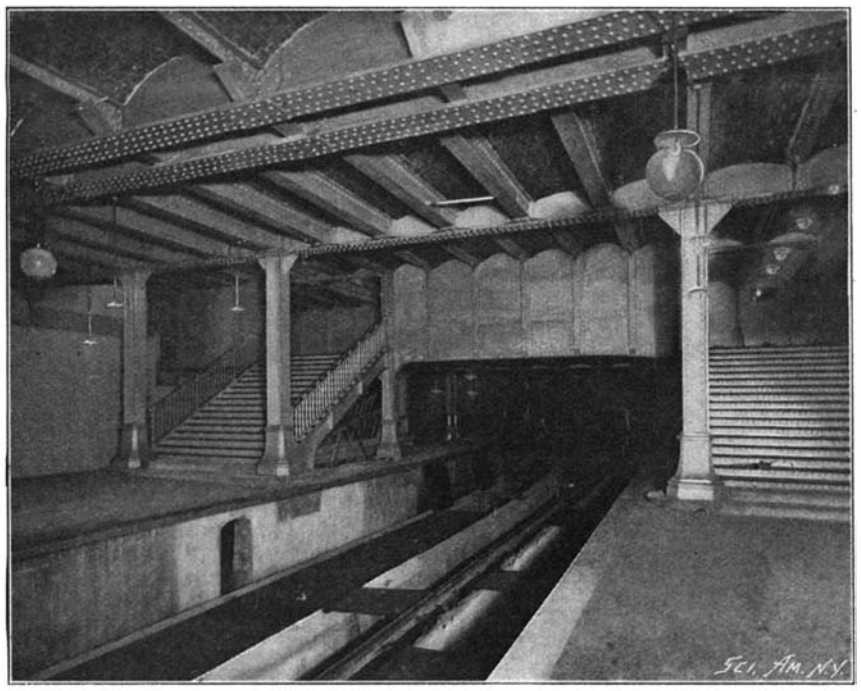
When the three lines which constitute the first section of the Metropolitan Railway are entirely completed, the total length of them will be 26 miles, but at present only the Porte Maillot and Porte de Vincennes Lines have been finished, and the extensions to the Porte Dauphine and the Place du Trocadéro are only partly completed. The total length of the main line and the two branches is 8¾ miles, the main line being 7 miles long. The main line calls for eighteen stations, but now eight only are being used. There are three stations on the line which runs from the Place de l'Etiole to the Porte Dauphine, and four on the Trocadéro branch. In reality there are in all twenty-three stations only, for the central station on the Place de l'Etoile is really a single station composed of three distinct parts. The stations are of five different types. One station is open, seven stations have metallic ceilings, and seventeen stations are vaulted. At the terminal stations the trains go around a loop, so that no switching is necessary. The ordinary tunnel sections have a maximum width of 23 feet 4 inches, and the clear space above the rails is 14 feet 9 inches. The stations are 246 feet long and 45 feet wide. The platforms are 13 feet wide, and are raised 3 feet above the level of the tracks. The total width of the cars is 7 feet 10½ inches, the gage being 4 feet 8½ inches.

At the Bastille Station, where the Metropolitan crosses the St. Martin Canal, there is an open cut and an open station, but with this exception the line runs entirely underground. The ticket offices are reached by stairs from the street, and all the passages, halls, etc., and the chief stations, are lined with white vitrified brick. The stations are well lighted, and the tunnel is also lighted throughout its extent. Some of the stations have their platforms connected by overhead bridges. The rate of fare on the road is five cents for first-class and three cents for second-class tickets.

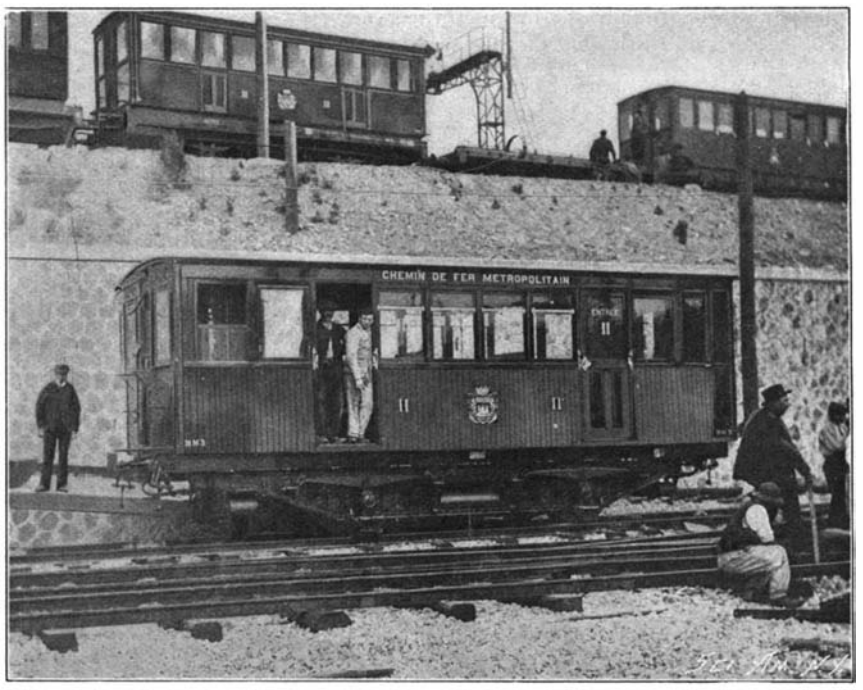


Tunnel, showing Third Rail

Vincennes Station and Tunnels.



Station on Metropolitan, showing Bridge Across Tracks.



Rolling Stock in Car Yard.

THE NEW PARIS UNDERGROUND RAILWAY.

Return second-class tickets are issued at an expense of four cents. There are no first-class return tickets, and even the use of the second-class tickets must be commenced before nine o'clock in the morning, as they are intended for the use of workmen. The distance is covered in about thirty-five minutes, including stops, which average twenty to twenty-five seconds. The trains will leave about every ten minutes, and each train has one motor car and two trailers.

The motor car is given up to second-class passengers. It accommodates twenty-eight persons and the trailers accommodate forty persons. The motor cars are provided with two hundred horse power motors, enabling a quick start to be made and a high-sustained speed while running through the tunnel. The track weighs 106 pounds to the yard. The current is conveyed by a third rail. The conductor rail is supported by insulators secured to every third or fourth tie. The cars are brilliantly lighted by electricity. The trailers have ten lamps and the motor cars eight lamps and two head or signal lights. At present twenty-two motor cars have been delivered and more than double that number have been ordered. The motor cars have the usual fuse boxes, lining, arresters, etc. Westinghouse air-brakes are used and the compressors are run by an electric motor. Contact is obtained with a third rail by means of two shoes, and in the car yards overhead wires are used. A four-wheeled trolley carriage running on the wire receives the current and delivers it to a motor car by means of a cable and plug.

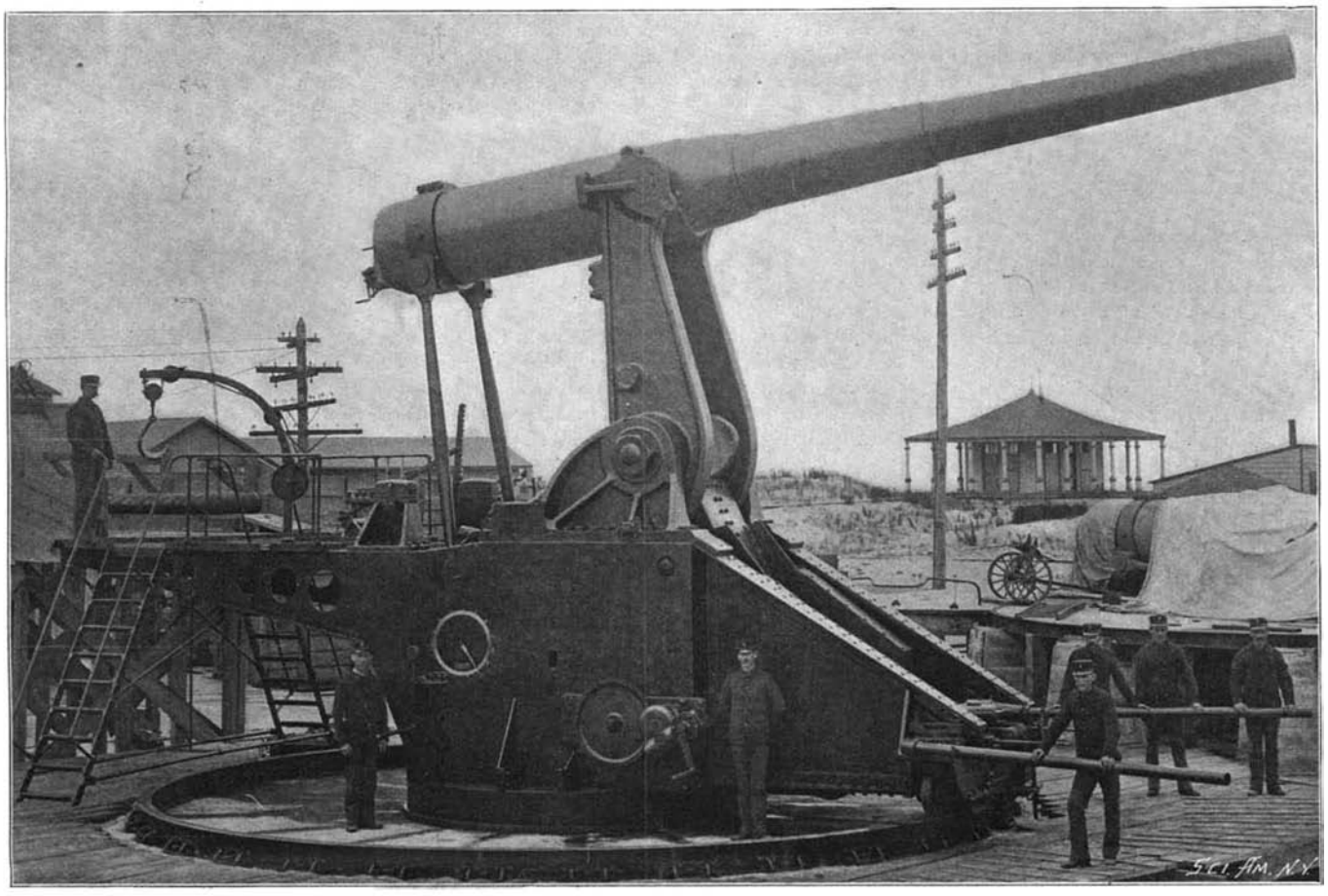
The electric power by which the cars are driven will be generated in a central power-house between the Quai de la Rapée and the Rue de Bercy. The boilers, engines, dynamos and auxiliary machinery have all been built by Schneider & Company, of Creusot. The Bercy power house will directly supply current for that portion of the road lying between Vincennes and the Louvre station. The other portion will also receive current from the main power house, but through the medium of a transforming sub-station at the Place de l'Etoile. The central station will consist of three batteries of six boilers each; a group of 1,500 kilowatt generators furnishing a direct current at a pressure of 600 volts; four groups of 1,500 kilowatt generators, furnishing a three-phase current of 5,000 volts and 25 periods; various auxiliary machines, exciters, transformers, and a battery of accumulators. Normally, the direct current is used for the Vincennes-Louvre section; but, if necessary, the three-phase system also can be called into requisition. In the sub-station, nine static transformers of 250 kilowatts each will step-down the 5,000 volt current to 360 volts. Three rotary transformers of 750 kilowatts each will feed current to the line at a pressure of 600 volts. The sub-station equipment also includes a battery of 250 Tudor accumulators of 1,800 ampere-hour capacity.

The total expense of the tunnels, viaducts, stations, etc., has been $7,400,000, and the company which has the concession has also spent a considerable sum. The concession is to run for thirty-five years.

The construction of the railroad is fully described in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 1211, 1226, and 1243.

THE HOWELL DISAPPEARING CARRIAGE.

The work at the Sandy Hook Proving Ground is by no means confined to the mere test of the ballistic qualities of the army guns; but considerable time is expended on the various gun-carriages that are submitted to the War Department. The mount is of only less importance than the gun, particularly in that class of mount which is designed to withdraw the gun behind shelter immediately upon its being fired.



TEN-INCH RIFLE ON HOWELL DISAPPEARING GUN CARRIAGE; FIRING POSITION.

The disappearing gun-carriage, which forms the subject of our illustrations, is now undergoing tests at Sandy Hook and has given fairly good results. It belongs to that type in which the gun is mounted on the extremities of two gun levers that rotate about a fixed axis. To the other extremity of the levers is attached a counterweight, which brings the gun from the loading to the firing position and assists in checking recoil when the gun is fired.

The principal parts of the carriage are: Lower roller path, rollers, upper roller path, chassis, main axle, gun levers, counterweight, main recoil cylinder, auxiliary recoil cylinder, elevating gear, retraction gear, traverse circle and traversing gear.

The distinctive feature of the carriage is the method of attaching the counterweight, there being an hydraulic and two telescopic spring cylinders, interposed between the bottoms of the levers and the weight.

When the gun is in its firing position, with the levers vertical, the counterweight, hanging freely by its upper end, from the main axle, lies in front of the gun levers, and is kept separated from them a distance of about twenty inches by the telescopic spring cylinders.

The hydraulic cylinder lies between the telescopic cylinders on the under side of the counterweight box, and is journaled to it by suitable bearings. The piston of this cylinder is attached to a cross shaft joining the ends of the levers, and in this position is withdrawn from the cylinder about twenty inches.

The general operation of the carriage is as follows: On firing, rotation of the system takes place about the main axle; the gun moves to the rear and downward, the gun levers being caught by a ratchet when the loading position is reached. The lower end of the levers moves forward and upward, compressing the spring cylinders, and forcing in the piston of the hydraulic cylinder, thus transmitting their rotation to the counterweight. The relative motion of about twenty inches allows the counterweight to gradually acquire the full velocity of recoil and greatly reduces the shock due to the sudden acceleration of so large a mass.

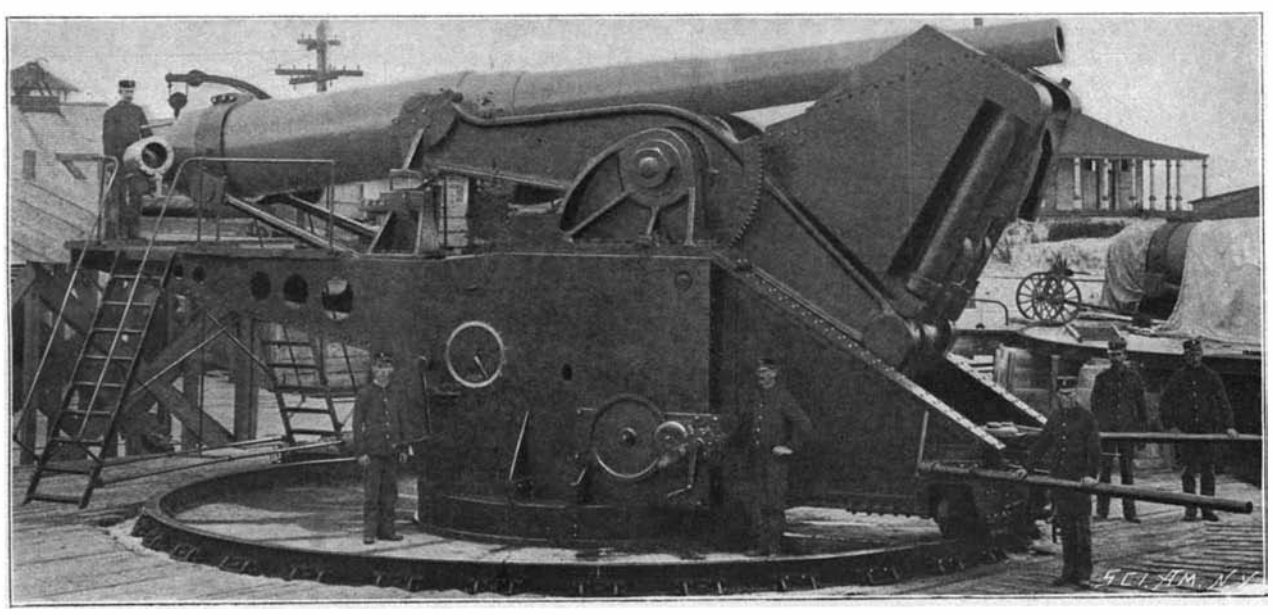
In the firing position nearly the total mass of the counterweight is suspended from the main axle, but during the recoil of the system, as the lever arms rotate from the vertical position, the weight is gradually transferred to them until in the horizontal position they carry practically the whole mass.

When the gun is loaded the ratchet holding the gun levers is released, the counterweight, due to its preponderance over the gun, moves downward and backward, carrying the system into the firing position; as the gun levers approach the vertical, the mass of the counterweight is again transferred to the main axle, and the telescopic springs force the lever arms away from the counterweight.

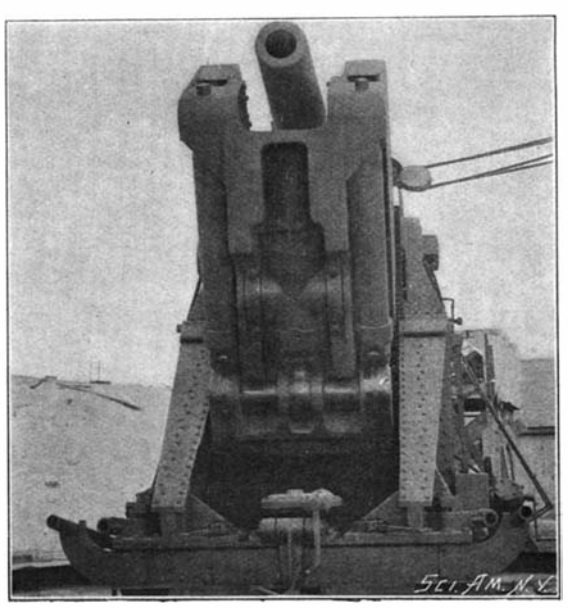
The main recoil cylinder is mounted in trunnion bearings between the chassis below the main axle; its piston being attached to the counterweight. When the gun is fired the piston is withdrawn; the oil passes through ports in the piston head from front to rear, forming the hydraulic brake, which absorbs the greater portion of the energy of recoil due to firing.

Two independent chains of gearing mounted on the two cheeks of the chassis engage in circular racks on the gun levers and serve as a means of lowering the gun from firing to loading position during practice drills.

The gun is elevated and depressed, either in the loading or firing position, by means of a band and two arms connected with two racks; the racks, actuated by



HOWELL DISAPPEARING GUN; GUN DEPRESSED.



FRONT VIEW.

spur gears, move in guides fastened to the inner faces of the cheeks.

In their report of the tests which have already been made, in which 26 rounds were fired with a 10-inch gun mounted on a carriage of this type, the Board states that, in the final firings for rapidity and accuracy, the general working of the carriage was satisfactory, although the loading angle was too great and the traversing mechanism was too slow and uncertain. The retraction mechanism was also criticised as being too slow, while the height of parapet required is twice as great as that of the service gun. "The great merit of the carriage," says the report, "is the absence of sliding parts."

A SIMPLE ROTARY PUMP FOR LIGHT SERVICE.

The Taber rotary pump, made by the Taber Pump Company, of Buffalo, N. Y., is an ingenious pumping apparatus which is intended for light service where a large amount of liquid is to be pumped against moderate pressure. It performs its work with but a small expenditure of power and in a comparatively short time.

The pump consists essentially of an outer shell inclosing a piston-cylinder which is provided with open ways or valve slots. Sliding valves, which are constructed with overlapping inner arms, are arranged in the ways so that they are forced through the piston by contact with the abutment and do not drop by gravity. Hence the pump can be operated at very slow speed to pump correspondingly as much liquid as at maximum speed.

Owing to the peculiar construction of the valves there can be no back lash and no lateral motion; as the driving shaft rotates, the valves pass in and out, back and forth through the cylinder, following the lines of the interior of the shell and creating a vacuum. The pistons are self-adjusting and compensating, and their operation is not dependent upon springs, cams, or similar devices.

A noteworthy feature in the construction is the absence of all gearing, the power being directly applied to the driving shaft through the medium of a belt and pulley or directly-attached engine or motor. The pump is positive in its action and does not depend upon speed to create the necessary vacuum. So large are the valve openings that the clogging of the moving parts is well-nigh impossible.

Pumps of this type are capable of discharging from 25 to 600 gallons per minute, depending upon the size of the pump, character of the liquid, and height to which it is to be forced. The pumps are adapted for use in connection with hot or cold, thick or thin liquids, and have been long successfully used in breweries, chemical works, soap factories, tanneries, creameries, oil mills, and packing houses.

The Diamonds of Steel.

It has not hitherto been suspected that our great metallurgic establishments were manufacturing precious stones. Yet nothing is more certain. It is true this has been done without intention, and without knowledge at the time.

Its possibility, however, might have been anticipated when M. Moissan made his experiments, ending with the artificial production of the diamond. He obtained this gem by suddenly cooling under high pressure the cast metal saturated with carbon. The same conditions are realized to a greater or less extent in the blast furnaces for manufacturing special steels, by sudden cooling of the fused metal under elevated pressure. In this class of steels there must be diamonds, microscopic without doubt, and Prof. A. Rossel, of the University of Berne, has been conducting experiments in the laboratory of inorganic chemistry for the purpose of ascertaining whether such diamonds really exist.

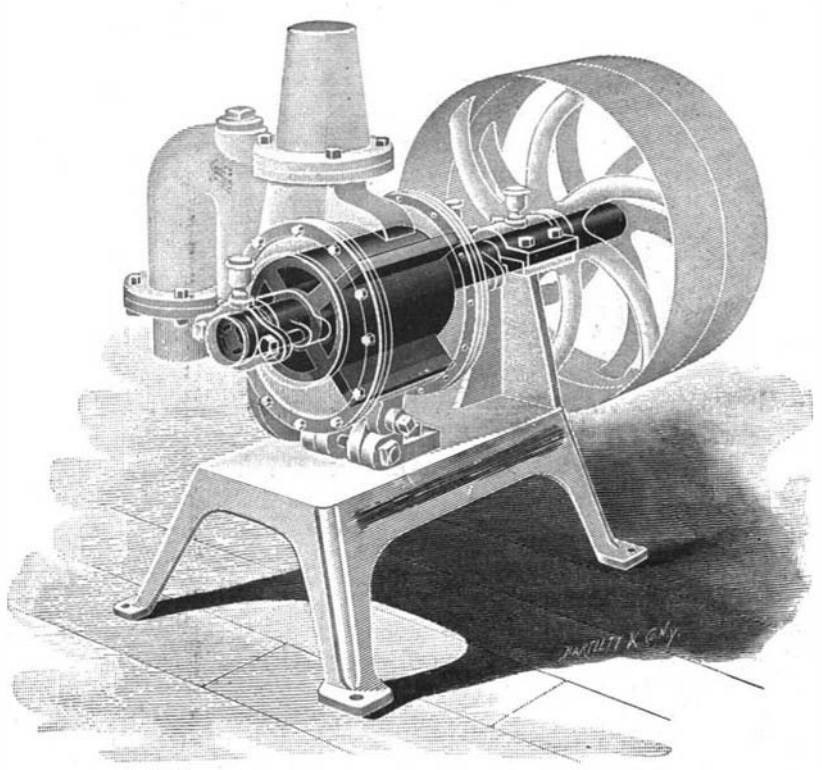
Already his conclusions have been presented to the Academy of Sciences, but one of his principal collaborators, M. Leon Franck, has recently prepared a detailed statement of the methods employed and the results obtained.

A considerable number of steels of various production have been examined and treated in the same manner. They all yield the same evidence. From a piece of compact steel a portion of about three hundred grammes was cut out and treated with nitric acid. The insoluble residue consisted principally of carbon, especially in the state of graphite, combinations of silicium, etc. It was washed with water and then boiled three times with fuming nitric acid, which partially dissolved it. They even obtained a dilution of the density of 1·8 by washing and successive additions of fluor-hydric acid; then of fuming sulphuric acid. There remained only graphite, which was washed, dried, and dissolved with potassium chlorate. This long series of operations was commenced again, for it was deemed necessary to pass the residue through the whole series of treatment that has been explained. At last, the chemist had the satisfaction, after a treatment of boiling sulphuric acid, of finding a deposit that could not be attacked.

The residue finally obtained with so much trouble fell to the bottom of a vessel filled with a heavy liquid as methyliodide. With the aid of a strong microscope, minute, transparent octahedrons were discovered, which burned on a leaf of platina, and in a current of oxygen, disengaging carbon, and almost without leaving ash. The proof was ample. M. Rossel had really discovered diamonds in steel.

The higher the temperature at which the steel has been made, the more diamonds it contains. This accords with the noted experiments of M. Moissan. It is probable also that the hardness of the metal increases with the number of diamonds it contains; in reality, they are the cause of its hardness. It is curious to observe that these diamond octahedrons are easily broken, so that in the steels worked, forged or rolled, only the débris of crystals were found.

In a still more interesting trial, M. Rossel believes he has ascertained that the ordinary casting is not the best dissolvent of the carbon and that, in view of the results, the method suggested by M. Moissan can be improved and perfected. The trial to which we allude took place on a loup, that is to say, on a block of metal mingled with scoria, which is formed at the lower part of the blast furnace when the operation is not perfect. This loup has been brought from a furnace of the factory of Esch-sur-l'Alzette in Luxembourg. It contained, among other things, a large quantity of crystalized graphite, and the washings isolated a large number of diamonds; all much larger than those that had been found in ordinary steel. One, that received the pompous name of the "Star of Luxembourg," measures more than five-tenths of a millimeter in thickness. Half a millimeter, perhaps, cannot yet compete with the "Star of the South," or with the "Regent"; but it must not be forgotten that it is a diamond procured artificially. Before long the blast furnaces of Luxembourg may be able to vie successfully with the commonplace mines of the Transvaal, where they are content to pick up what nature has already provided. —Le Diamant.



ROTARY PUMP FOR LIGHT SERVICE.

Utilization of Photographic Plates.

The following method has been given by which photographic plates, which have been fogged or accidentally exposed to the light, may be utilized for making glass positives or lantern slides. A solution is made up of 100 parts distilled water, 6 parts bromide of potassium, and 50 parts chloride of copper. The plate is exposed for one or two minutes at one foot distance from an ordinary gas flame and by orange or red light, is placed in the preceding solution for eight or ten minutes, then washed fifteen minutes in water and dried in the dark. Under the action of the bath, the bromide of silver in the plate is changed to chloro-bromide. The plate is then printed under a negative for twenty to thirty seconds in daylight, or from two to five minutes at one foot from a gas flame; it is then developed in the following bath:

Water	1,000 parts.
Hydroquinone	10 "
Sodium carbonate	100 "
Bromide, 10 per cent solution	1 to 3 "

The ingredients are dissolved in the order indicated. If desired, an ordinary hydroquinone developer may be used, adding a considerable amount of bromide. After development, rinse and fix in a 15 per cent hypo solution, or preferably a fixing bath of 1,000 parts water, 150 parts hypo, 50 of sulphite of soda, and 50 of common salt; the fixing lasts about ten or fifteen minutes, after which the plates are washed, as usual, and dried.

Incandescent Gas Light.

The Photographische Chronik warns its readers, says The British Journal of Photography, against tables of the comparative chemical action of various kinds of light, when an incandescent mantel is used for a standard light. "Lux," a Dutch contemporary, has given the following information concerning the solutions used for the preparation of gas mantels, and it will be seen that the light varies considerably according to the salts used.

FOR WHITE LIGHT.

Zirconium oxide	40 per cent.
Lanthanum oxide	40 "
Thorium oxide	20 "

FOR ORANGE LIGHT.

Lanthanum oxide	40 per cent.
Thorium oxide	30 "
Zirconium oxide	27 "
Didymium oxide	3 "

FOR YELLOW LIGHT.

Lanthanum oxide	40 per cent.
Thorium oxide	28 "
Zirconium oxide	30 "
Cerium oxide	2 "

FOR GREEN LIGHT.

Thorium oxide	50 per cent.
Lanthanum oxide	20 "
Erbium oxide	30 "

The mantel is afterward stiffened with a solution of water glass. Concerning the intensity of the light which may be obtained with gas mantels, if we take 60 candles as the equivalent of a mantel, 1020 candle power may be had from 17 mantels, which, with suitable reflectors, may be increased tenfold, say 10,000 candles in round numbers. By diffusing the light with paraffin paper screens a loss of 20 per cent results, but if we place two rows of 6 mantels each on one side of the sitter, and a row of 5 mantels on the shadow side, there still remains sufficient light to obtain full exposure in a few seconds.

Aerial Telegraphy.

M. Tomassina, who has been making a number of experiments in aerial telegraphy, has invented a device to prevent the interception of a message by an intermediate apparatus, and has communicated his results to the Académie des Sciences. The fact that the message may be intercepted constitutes one of the chief drawbacks of the system. M. Tomassina proposes to overcome the difficulty by using a method based on the fact that the distance to which the electric waves may travel depends upon the interval between the two spheres of the oscillator, and by thus regulating the length of spark the limiting distance of the signals may be determined beforehand. To the first transmitter is added a second, whose manipulator sends an irregular series of waves quite out of connection with the waves sent by the first transmitter; the second set of waves is regulated for a zone of action which is somewhat smaller than that of the first. In this way a receiver placed on the zone of the second set will receive only a confusion of signals, and the message cannot be read. It is only possible to read the signals of the first transmitter when the receiver is placed outside the zone of action of the second. The security will be greater as the two zones approach each other.

Discovery of Standard Weights of Ancient Rome.

The excavations that have been in progress for some months past upon the site of the ancient forum at Rome have resulted in quite a curious discovery. Under a large, square flagstone there were found three weights of twenty, thirty, and one hundred Roman pounds dating from at least two centuries before our era. These weights, which are of irregular elliptical form, are of dark green marble and provided with a bronze handle in order to facilitate their manipulation. In the opinion of Signor Giacomo Boni, who is superintending the excavations, these are the most ancient specimens of standard Roman weights known, and, since they are perfectly well preserved, without the least fracture, they will permit archæologists to reestablish the entire metrology of primitive Rome. They have already been compared with the weights now in use, and it has been found that the ancient Latin pound was exactly 325 grammes (10 ounces and 75 grains). The weights, moreover, are well proportioned according to the numerical indications that are engraved upon the stone and that are still legible. The 20-pound weight represents exactly two-thirds that of the 30-pound one and one-fifth of the largest, which weighs 30 kilogrammes and 250 grammes (about 66½ pounds).—La Nature.

GATHERING AND CURING CRUDE RUBBER.

Crude rubber is imported into this country from many widely separated sections of the globe, and in a wonderful variety of forms, the chemical characteristics of the substance changing widely under varying conditions of harvesting, curing, etc.

The first knowledge of rubber is said to have been secured through La Condamine, a French philosopher, who in 1730 was sent by his government to Peru to measure an arc of the meridian, the specimens he secured going to form museum exhibits. South America produces the best rubber in the world, as well as the most of it. The Amazon Valley, embracing rubber forests in Brazil, Bolivia, and Peru, is the center of the industry, the product being exported from the city of Para, whence the name Para rubber.

CURING PARA RUBBER WITH THE FUMES OF THE URUCURU NUT, UPPER AMAZON RIVER.

GATHERING PARA RUBBER IN THE UPPER AMAZON RIVER.

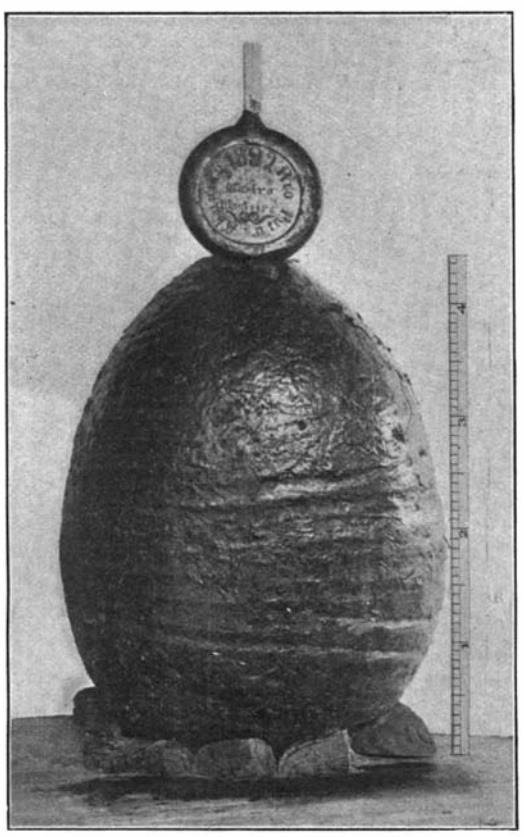
The tree which produces rubber, or caoutchouc, as it is called by the natives of South America, is found chiefly in the tropical zone. The rubber trees on the Amazon rise without branches to a height of from 50 to 60 feet, being topped off by deep green leaves six or seven inches in length. Peru's product, lower in grade than Para, is known as "Caucho." The rubber trees of Nicaraugua and other Central American States, also found in Ecuador, Venezuela, Colombia, and Mexico, produce rubber known as "centrals." The Atlantic States of Brazil, south of Para, produce rubber trees from which come the grades known as "Mangabeira," "Pernambuco," and "Ceara."

Africa comes next to South America in the amount of rubber produced, and in the interior of that country there are great rubber forests as yet untouched. Rubber is to be found on the east and west coasts and also on the Island of Madagascar. The East Indies furnish comparatively little rubber, the first exported coming from Assam, one of the rubber trees of which district is shown in the accompanying illustration.

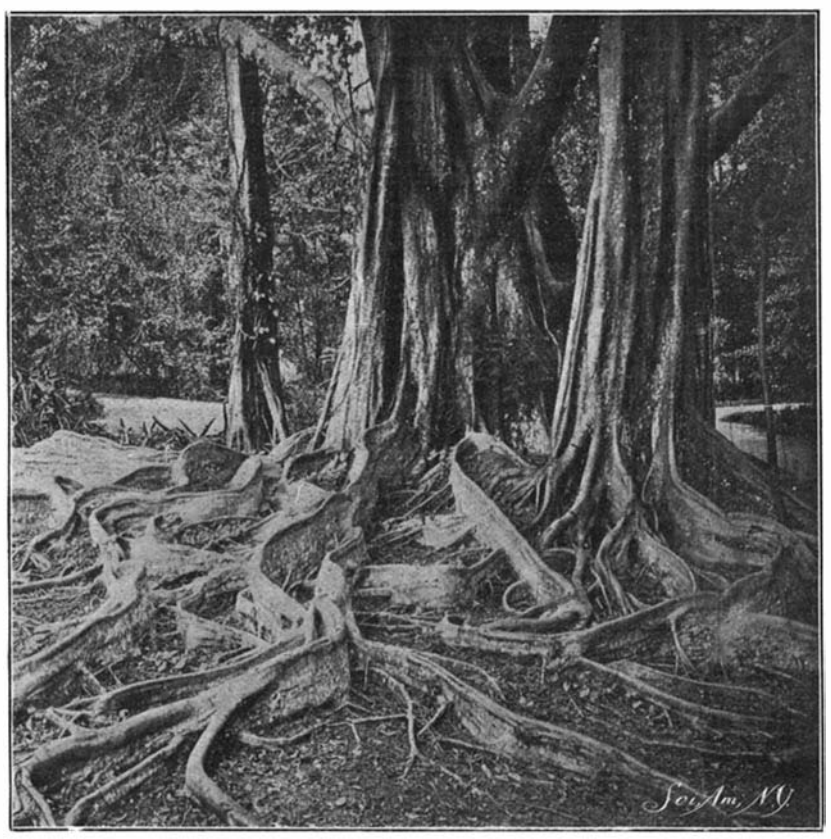
The rubber from the Cameroons is in the shape of little black balls, while that from districts farther up the African coast comes in the shape of flat, ugly fragments, known as "oysters."

Fine Para rubber reaches this country in the form of "biscuits," the excellence of this grade being due in a large measure to the natives' methods of gathering and curing it. They make a longitudinal gash in the bark of the tree with a narrow hatchet, inserting a wedge to keep the gash open, and placing a small earthen or clay cup beneath the gash to catch the thick, white, oily liquid which flows from the wound. In a few hours the milk ceases to flow, each wound yielding from three to five tablespoonfuls. The "Seringero," or gatherer, then empties the contents of the cups into an earthern vessel, as indicated in the accompanying illustrations. As the milk soon coagulates the gathering is quickly followed by the curing process, which is done by building a fire of Urucuru nuts, over which is placed the bottomless earthen jar or pot shown in the illustration, the pungent fumes issuing through the small aperture at the top serving to "cure" the rubber, which is passed slowly through the hot smoke.

To form the biscuits, the natives take long stakes of wood, sometimes pointed at the end, and quite frequently shaped like a paddle, dip them into the sap buckets or basins, holding them in the smoke after each dipping, until the successive films of rubber solidify around them. A biscuit of Para rubber, therefore, represents the slow and laborious accumulation of hundreds of dippings, so that quite a stretch of the imagination would be necessary to arrive at the number of dippings required to form the huge Para biscuit illustrated herewith, which weighs 1,120 pounds and measures 4 feet 5 inches in height, 3 feet 5 inches in diameter, and 9 feet 4 inches in circumference. Such immense masses of crude rubber are said to actually represent a loss to the grower, being used principally by importers for exhibition purposes. Sometimes the natives use a stone as a nucleus, and, to prevent this method of securing an illegitimate profit, the biscuits are split in halves before shipment so as to reveal the stake hole running through the middle.



HUGE BISCUIT FINE PARA RUBBER WEIGHING 1,120 POUNDS.



RUBBER TREES IN THE ASSAM DISTRICT OF EAST INDIA.

Residues, and What to Do With Them.*

Briefly, I may tell you that I found the residues of the gold toning bath so much resembling the residues I had to do with in my business of a goldsmith, that I determined to find what the value of the old toning baths really were. To that end I dissolved 2 ounces of sulphate of iron in a quart of hot water. This I put into a two-gallon jar, and as the baths were used up they were poured into the jar after two years. The precipitate was filtered, dried, and burned in an old iron ladle; it was then a heavy brown powder. To this I added twice its weight of pearl-ash, and after much mixing in a mortar, put into a crucible and submitted to a strong heat for an hour, and this gold was in the bottom of the crucible and weighs ¼ ounce troy.

I had it flattened out to what you see, just in the state in which gold-beaters use in the manufacture of gold leaf. The amount of gold recovered I estimate to be 70 per cent of the twenty-four 15-grain tubes bought. I expected to have found some silver from the albumenized paper toned, but I did not. The gold by assay is 23⅝ carats of fine, or 996 in 1,000.

This is a button similar to the first, only heavier. Of silver residues I have saved only the first washings and trimmings of albumenized paper. Common salt was used as a precipitate, and treated generally the same as the gold; it weighed over 11 ounces when it was put into the crucible, now it weighs nearly 5 ounces. These products prove most conclusively the value of residues.

* Paper read at the Photographic Convention of the United Kingdom, July, 1900, by S. B. Webber, reported in The British Journal of Photography.

The Archæological Exhibit of the Department of Fine Arts.

The archæological exhibit of the Department of Fine Arts at the Paris Exposition shows the different expeditions which have been made by the French Government. The Archæological College of Athens has been for some time engaged in excavations at Delphi, and the present state of the work is shown. The sanctuary of Apollo has been almost entirely uncovered; it includes the main temple, theater, and a great number of surrounding structures. But little remains, however, above the foundations, as is shown by a large water-color sketch of the ruins; another sketch shows the restoration; the temple is surrounded by a number of small buildings or pavilions, which contain the offerings made by the different nations. The façade of one of these, belonging to Cnidos, is reproduced in actual size, being about 20 feet long and 25 feet high. The portico is upheld by two caryatides of singular form, somewhat in the archaic style, standing upon square pedestals; the cornice has reliefs representing battle scenes; those of the entablature represent a number of figures seated. Two archaic statues of Apollo are shown, and several figures of a more recent style. The column and the sphinx of the Naxians and an acanthus column surmounted by three female figures are shown in full size. A number of other collections are shown, including that of the expedition of M. de Sarzec in Chaldea, completing the large collection already at the Louvre.

THE Trans-Siberian Railroad will be completed at the present rate of working in about two years, the cost probably considerably exceeding the original estimate of $175,500,000.

The Railroads of Europe 1875-1899.

The table which follows has been compiled and converted from l'Economiste European, of Paris, by the Philadelphia Commercial Museum :

RAILROADS OF EUROPE ON JANUARY 1, 1875, AND JANUARY 1, 1899.

	Miles, 1875, per Million of Inhabitants.	Total.	Miles, 1899, per Million of Inhabitants.	Total.
France	352	12,898	670	25,897
Germany	381	16,109	563	30,776
England	499	16,449	527	21,528
Austria-Hungary	273	10,083	483	21,805
Belgium	324	2,131	560	3,781
Bulgaria	324	2,131	178	616
Denmark	339	635	669	1,617
Spain	211	3,484	445	8,102
Greece	4	7	232	591
Italy	166	4,578	305	9,759
Luxemburg	827	169	1,210	270
Netherlands	261	984	329	1,694
Portugal	137	641	280	1,466
Roumania	150	766	332	1,894
Russia	126	9,665	232	24,808
Finland	249	465	604	1.605
Servia	249	465	144	353
Sweden	514	2,235	1,247	6,359
Norway	22	311	571	1,230
Switzerland	371	1,017	730	2,302
Turkey	111	953	154	978
Isles of Malta	....	....	....	....
Jersey and Man	....	...	211	68
Total	5,317	83,680	10,676	167,439

The Kachin Developer.

We have submitted, says Photography, the new kachin developer to a most vigorous test ; we have developed over a hundred negatives with it, using the formula given below. One cannot wish for a more satisfactory developer. It does not stain the plates or the fingers, and has no injurious action upon the skin. It gives good brownish-black negatives, quite free from fog, without the necessity of employing any bromide or other restrainer whatever. Development with it took about six to ten minutes to complete, ample density being obtained very easily.

The formula which we adopted to secure so excellent a result is a simple one. Three solutions, each ten per cent, are required : One of sodium carbonate, one of sodium sulphite, and one of kachin. In making up the ten per cent solution of kachin, instead of water some of the ten per cent sodium sulphite solution is used. For each ounce of developer we took :

Kachin (ten per cent solution)	40 minims.
Sodium carbonate (ten per cent solution)	½ ounce.
Sodium sulphite (ten per cent solution)	½ ounce.

We got, as will be seen, a trifle more than an exact ounce, but such a difference is unimportant, and the composition of the developer is easier remembered in this way.

The solution, as we finally used it, will be seen to contain approximately 4 grains of kachin, 26 grains (22 + 4) of sodium sulphite, and 22 grains of sodium carbonate.

Another formula, given in a little book entitled "How to Develop with Kachin," is as follows :

	British System.	Metric System.
A. Kachin	160 grains (avoir.)	9 grammes.
Sodium sulphite (cryst.)	2½ ounces.	62·5 "
Water up to	20 fluid ounces.	up to 20 c. c.
B. Sodium carbonate (cryst.)	2 ounces.	50 grammes.
Water up to	20 fluid ounces.	up to 500 c. c.

For use, take equal parts of A and B. More diluted developer gives softer results The solutions should be used at a temperature of 60° to 65° Fahr. Assuming exposure to have been correct, with this solution the image commences to appear in about one minute, and, when full density is required, development is completed in from four to six minutes. Softer effects are obtained in from three to four minutes.

For stand development, the plates are placed, a dozen or more at a time, in a grooved trough containing the developer, and development continues with a rapidity depending upon the strength of the solution.

With the following solution normal development is completed in about ten to fifteen minutes. To prolong development add more water :

	British System.	Metric System.
Kachin	115 grains.	7·5 grammes.
Sodium sulphite (cryst.)	560 "	36 "
Potassium ferrocyanide	140 "	9 "
" bromide	23 "	1·5 "
" carbonate	1,150 "	75 "
Water up to	70 fluid ounces.	up to 2 liters.

Throughout these experiments we employed no bromide or other form of restrainer whatever. Our plates, having been exposed (on all sorts of subjects) with an exposure meter and not by guesswork, were all correctly exposed, and however much they differed in the nature of the subject they developed up well with the very simple solution we have named. Bromides seem to have little effect on kachin. This is well shown by the fact that three or four plates can be developed one after another in the same solution without any marked prolongation of the time of development. With most developers, as our readers well know, this is not so. The soluble bromide liberated from the plate into the liquid during development acts as a restrainer, and retards the action of the solution upon the next plate that is put into it. With each plate that is developed it will be seen, then, that the developer is not only getting weaker in the active agent, but is also getting stronger in restrainer.

On the subject of restrainers it has been found that a four per cent solution of ordinary borax used with kachin in the proportion of ten to thirty drops to each fluid ounce results in the production of enormously increased contrast. Plates which have received an exposure of many times the normal may be converted into satisfactory, and even brilliant, negatives by the judicious use of borax in the developer.

Building Loan Associations.

The secretary of the United States League of Local Building and Loan Associations has compiled the following statistics for 1899, which will be found interesting, as no data of this nature is collected through any other source from year to year. It should be remembered that the figures do not include "national" associations ; only those that are local and truly co-operative :

States	Associations.	Members.	Assets.
Pennsylvania	1,174	281,456	$12,120,436
Ohio	773	287,477	102,400,699
Illinois	599	100,000	54,104,602
New Jersey	335	90,100	46,100,000
New York	299	89,409	37.253,725
Indiana	424	109,043	31.435,587
Massachusetts	125	68,349	26,744,647
California	151	37,780	20,285,454
Missouri	191	38,000	13,835,817
Michigan	72	32,775	10,159,562
Iowa	79	23,000	5,723,769
Connecticut	15	12,773	3,774,526
Wisconsin	52	13,450	358,902
Kansas	46	12,000	2,880,764
Nebraska	60	13,813	3,332,781
Maine	32	8,115	2,975.716
Tennessee	26	4,795	2,874,097
Minnesota	46	7.500	2,848,179
New Hampshire	17	4,950	1,921.927
North Dakota	7	1,000	364,130
Other States	962	267,800	97,137,800
Totals	5,485	1,503,625	$581,857,170

The Current Supplement.

The current SUPPLEMENT, No. 1286, is an unusually interesting issue. There is an excellent portrait of King Humbert, and also portraits of the present King and Queen of Italy. "The Borsig Engine" at the Paris Exposition gives a full-page engraving of this great engine. "The Future of the Automobile" outlines suggested improvements. "Excavations at Tell-el-hesy, the Site of Ancient Lachish, Syria," is an elaborately illustrated article. "Microbes—What Are They?" is by Dr. Henry G. Graham.

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RECENTLY PATENTED INVENTIONS.

Agricultural and Logging Implements.

GUIDE AND SUPPORT FOR DRAG-SAWS.—EDGAR F. LAFAYETTE, Sedro, Wash. This invention is a small device adapted for attachment to logs or felled trees for guiding or supporting a drag-saw while they are undercut. The device embodies spikes hinged to a bar and adapted to be driven into the log, and a slide adjustable along the bar to support the saw in proper position. The spikes can be folded flat upon the bar so that the entire device occupies but little space.

PLOW. — RICHARD H. PURNELL, Rosedale, Miss. The beam of the plow is made of metal tubing. The cultivating devices are carried by a standard formed with a concave or semicircular upper edge in which the beam fits. The beam and semicircular portion of the standard are bound together by a coupling-band. The entire arrangement is such that great rigidity is secured, as well as lightness and simplicity.

Electrical Apparatus.

ELECTROLYTIC APPARATUS. — ANDREW PLECHER, Habersham and Second Streets, Savannah, Ga. This apparatus is to be used for electrically decomposing any liquid into its constituent gases and especially for decomposing water into hydrogen and oxygen. The apparatus is spheroidal in shape and consists of two separate, closed cells having registering openings by which they communicate. An encompassing band or jacket completely encircles and holds them together. The cells are provided with electrodes, circuit-wires, and gas-discharging pipes. The inventor has been particularly careful so to construct his apparatus that it can be readily transported, that the greatest possible electrode surface is obtained, and that repairs can be easily made when desired.

GAS-BATTERY. — ANDREW PLECHER, Habersham and Second Streets, Savannah, Ga. The surface action of sponge-platinum causes two gases (oxygen and hydrogen) to unite, as every one knows, and to heat the platinum red hot so that the gases are automatically ignited. It is Mr. Plecher's purpose to prevent the production of heat attending the union of the gases and to get its equivalent in electric current. In a porous cell finely-divided platinum is placed. To one side of the cell hydrogen is conducted; to the other, oxygen. When the hydrogen and oxygen unite through the action of the platinum, suitably placed electrodes will gather the liberated forces of opposite polarity as union takes place and carry them off through the conducting wires of an extraneous circuit.

ELECTROMAGNETIC TELEPHONE. — ANDREW PLECHER, Habersham and Second Streets, Savannah, Ga. The telephone includes in its construction an iron box to which an iron circuit-wire is attached. In order to render the boxes magnetic an insulated wire is wound around the circuit-wire. The box is provided with two diaphragms between which a variable-resistance medium is suspended. A small bulb is used to increase or decrease the air-pressure in the box and thus to regulate the amplitude of movement of the variable-resistance medium. The two diaphragms, as they vibrate in opposite directions in response to the vocal impulses, augment the effect on the resistance medium one hundred per cent. The fluctuations are electrically transmitted.

TIRE-SEPARATOR.—DELORE J. LAHAY, Nadeau, Mich. Ordinarily the two sections of a double tube tire adhere to each other so tenaciously that their separation is a matter of no little difficulty. The present invention provides means whereby this separation can be easily accomplished. The means in question comprise a frame or body portion capable of encircling the inner tube and provided with anti-friction wheels or rollers upon which the tire is compressed. The separator is movable between the two tubes to force them apart.

Vehicles, Harness, Etc.

DRAFT-EQUALIZER. — JOHN A. BELTZ, Buxton, N. D. This draft-equalizer, comprising broadly two doubletrees held to rock upon each other and also upon a wagon-pole, prevents any animal in a four-horse team from shirking his duty; for the pull of one horse will be thrown upon the neck of the delinquent animal. The draft-strain is entirely disposed at the rear end of the pole, so that the animals pull with greater effect in moving the loaded wagon than is otherwise possible. The device is so constructed that the forward pair of animals control the side movement of the wagon-pole together with the rear pair of animals and must pull equally with them, an arrangement particularly serviceable in rounding corners.

BIT.—MICHAEL MCNALLEY, St. Louis, Mo. The bit invented by Dr. McNalley is designed to induce a horse to carry his head outward and away from the chest rather than to drop his chin in the direction of the chest. The bit is simple and durable, and is so made that it will not irritate the horse or tend to injure the jaw or mouth.

Industrial Apparatus.

MAGNETIC SEPARATOR.—CHARLES F. COURTNEY and ROBERT BUTTERWORTH, Broken Hill, New South Wales. Comminuted ore or other mixture is passed through a highly-concentrated magnetic field in the form of a film, so as to prevent the paramagnetic particles from becoming prematurely detached from the magnetic poles and swept away by contact with the passing stream of matter of lower magnetic permeability with which they are associated. The material is prevented from falling freely until it enters the magnetic field, so that the particles, however low their magnetic permeability, are not lost. The invention is also adapted to separate paramagnetic substances of different degrees of magnetic permeability. For, by regulating the intensity of the magnetic field and the time during which the material is acted upon, a substance having a certain degree of magnetic permeability can be obtained.

CURTAIN FOR DUST-COLLECTING APPARATUS.—ARTHUR S. DWIGHT, Kansas City, Mo., and RUDOLF RUETSCHI, Argentine, Kans. In order mechanically to precipitate and collect metallic fumes and flue-dust in metallurgical establishments, the inventors employ curtains, the members of which present oblique surfaces or facets to the longitudinal currents of the gases between adjacent curtains, so as to divide the current into a larger number of smaller oblique currents and to form eddies or whirls near the facets. Thus is insured a thorough and rapid mechanical precipitation of the solid matter in the gases on the surfaces or facets. The inventors obtain a large frictional surface for a very short flue, and therein resides one of the merits of their device.

Railway-Appliances.

SPRING-SEAT.—WILLIAM BORCHERT, Carson, Nev. The seat is particularly adapted for use in locomotive-cabs. It is provided with such equalizing devices that it will always be parallel to the base, so that all springs will be equally compressed whether a man sit on a corner or edge. The seat is, therefore, comfortable under all conditions.

Miscellaneous Inventions.

SASH-HOLDER.—JOHN BOHLEN, Big Rapids, Mich. The sash-holder is designed to be used in connection with a rack of any kind and is so constructed that it can be locked in or out of engagement with the rack and supported in such a manner that the window to which it is applied may be conveniently operated when the latch is out of engagement with the rack.

LOCK. — THOMAS CHURCHILL, Hampton, Va. Mr. Churchill has already patented a lock in which the outer knob is made incapable of turning the spindle except when temporarily locked thereto by a key which is inserted concentrically through the knob and is made to act upon clutch devices which cause the knob to be coupled to the spindle. The present invention comprehends further improvements relating more especially to the locking or clutch mechanism which connects the knob with the spindle and which is applicable to any of the ordinary forms of locks, having the usual squared spindle.

SIGN OR SIGNAL FOR CALLING CABS.—ARTHUR G. R. NICHOL, Manhattan, New York city. The invention provides a simple means whereby a clerk in a hotel or theater may call cabs or other carriages successively or simultaneously. Electric lamps of various colors are used, which are flashed by inserting plugs in proper openings. In order to prevent mistakes, the plugs are made to fit only the contact plates for which they are intended. And in order still further to guard against mistakes, plugs of like shape are connected by strings. Hence the operator can not inadvertently leave one plug of a set in a contact-plate; for the entire set must be removed before the connecting-string can be taken off the switchboard.

VENTILATED BOOT OR SHOE.—JAMES J. PEARSON, 40 Wall Street, Manhattan, New York city. This ventilated shoe is provided with a ventilating mat interposed between a perforated insole and the outer sole. The mat is of elastic rubber and is connected with a channel leading to the heel-vent of the shoe for the ingress and egress of air. The most prominent feature of the invention, a feature, which, it is claimed, is not possessed by any similar shoe, is the impossibility of entrapping air in the sole. The air circulation is free, longitudinally and laterally. The cushioned tread, reinforcing devices, and cheapness of manufacture are other features which deserve to be mentioned.

COMBINED HEATER-SHIELD AND VENTILATOR.—ALLAN B. SHANTZ, Walkertown, Ontario, Canada. Much danger is incurred by improper ventilation and especially by arrangements which draw air into a room from a point near the ground, since the gases arising from decaying animal and vegetable matter must also be drawn in. The present invention provides an apparatus by which air is received from an elevated point, the lower impure strata being withdrawn from the room. The novel feature of the invention is an ingenious double-walled shield used in connection with a heater.

TAPE-MEASURE ATTACHMENT.—CORNELIUS H. ELKSKAMP, Telluride, Colo. The inventor has busied himself with the production of an attachment for the end of a tape, which attachment can be readily applied to a floor, stake, post, or the like, so that the tape can be readily run out. The end of the tape is provided with an eye in which a link is held pivoted in a post of such construction that it can be readily driven into a floor, tree, or the like.

PICTURE-FRAME.—ALBERT F. MESSINGER, Phœnix, Arizona Territory. The inventor has devised a novel construction which enables him to mount exteriorly on the frame a picture representing a building, and to move this picture out of sight so that a second picture is made to appear, which represents the interior of the building shown on the first picture. The device is particularly useful for advertising purposes, since it combines in one arrangement views of the exterior and interior of a business establishment.

DUPLEX PENHOLDER. — HARVEY and FRANK LONGENECKER, Beamsville, Ohio. This penholder contains a simple mechanism which permits a ready projection of one pen-socket and at the same time causes

the retraction of another socket to enable the writer to make use of separate pens for different inks, without one pen interfering with the other. In the case of the penholder a right and left hand screw is mounted, the threads of which are engaged by pen-sockets. When one socket is moved in one direction, the other is caused to travel in an opposite direction.

FEED-RACK.—JAMES MORRIS, Westchester, Bronx, New York city. This rack is so constructed that it can be easily put up in a stall and taken down and folded for transportation, thus particularly adapting it for racing stables, in which it is desirable that each horse should have his own rack to avoid danger of contagious diseases.

CHAIR-SEAT SUPPORT. — HEZEKIAH MORTON, Thomasville, N. C. The support comprises crossed straps extended under the chair-seat in order diagonally to connect a front leg with a rear leg of the chair. Each strap consists of two spaced pieces connected at the ends. Adjusting and supporting bolts extend from the legs through openings in the end connections; and nuts on the inner ends of the bolts abut against the end connections and are prevented from turning by engaging with the members of the straps. A very firm brace is thus formed which prevents the seat-frame from breaking and the parts of the back from spreading.

FRAME FOR BAGS, PURSES, SATCHELS, ETC., LOUIS B. PRAHAR, Brooklyn, New York city. A locking device has been provided by the inventor in which a catch-button has a rocking and guided movement on a member of the frame. The button can be released from a locking stud or studs on any number of members of the frame by a simple rocking movement from one side to another or by an upward movement.

BREAD OR CAKE-PAN.—MARIE VOSSBECK, Trinidad, Colo. The pan is made so that the parts can be quickly and conveniently detached, buttered, and assembled. When the loaves have been baked the body and bottom of the pan can be removed from engagement with the partitions, which partitions serve to hold the baked loaves apart and yet permit them rapidly to cool.

CIGAR-WRAPPER. — FRANCISCO E. FONSECA, 22 Fulton Street, Manhattan, New York city. Mr. Fonseca has received a patent for a novel paper cigar wrapper, the ends of which extend beyond the cigar and are twisted to form cords which are wound back upon the cover and secured. No matter how roughly the cigar may be handled, the wrapper will always maintain its position to protect the cigar. The twisted ends serve as cushions, which prevent the cigar from being damaged. One object of the invention is to enable the manufacturer to print descriptive matter on the wrapper. The invention has been practically applied and seems to fulfill its inventor's expectations. For presentation this cigar is specially adapted. Each cigar may bear the name of both the donor and recipient.

FIRE-EXTINGUISHER. — JOHN BRAUNWALDER, Davenport, Iowa. This fire-extinguisher is of a type in which a container for an extinguishing liquid is designed to be broken so that the liquid can escape. The invention seeks to furnish a means for breaking the container, which means are actuated by fire. These means consist of a powder-chamber and a fuse. When the fuse is ignited, the powder will eventually be exploded and the liquid-container shattered.

VIOLIN.—LOUIS H. HALL, Hartford, Conn. The body of the violin consists of a rim or ribs, to which a top and a bottom are secured. The edge-portions of the top and bottom at certain points are under a strain and tend to separate from the ribs. This tension is beneficial in more than one respect. It improves the tone; it opposes the pressure produced by the bridge and strings and, therefore, strengthens the body of the instrument; and it enables the inventor to vary the quality of the tone simply by giving more or less curve to the bottom and top.

AMIDOSULFONIC ACID.—JOSEPH TURNER, Huddersfield, York, England. Amidosulfonic acids, according to this invention, are produced from nitro bodies of the phenolic and carboxylic series by the action of sodium bisulfite. The products obtained combine with phenols, are slightly soluble in alcohol, insoluble in benzin, form crystallized diozo compounds with nitrous acid and all the sodium salts, and are very soluble in water.

BABY-EXERCISER.—CHARLES E. LATSHAW, Lincoln, Neb. The exerciser is a "baby-jumper," consisting of a spring-suspended frame of novel construction, in which the baby is supported. The elastic support enables the child to use its legs freely in springing or jumping, thus combining the benefits of exercise and amusement without requiring close watching.

NON-REFILLABLE BOTTLE.—JOSÉ M. URGELLÉS, 8½ Ricla Street, Havana, Cuba. Two balls are held in a valve-seat arranged to be locked in the neck beneath the cork. The larger ball acts as a valve to permit the outflow of liquid, and the smaller acts as a back bearing to follow up and hold the larger ball to its seat.

TRUNK-HANDLE. — BERTNIE M. WILHITE and FRANK A. HOYT, Gordon, Neb. In the handling of trunks, the pinching of the fingers between the handle and the trunk body is frequently experienced. To prevent this, the handle above noted is so connected by its ends that when gripped it slides outward in diagonal slots in the securing devices and so as to stand out from the trunk body.

TRAP. — THOMAS H. TAYLOR. Luzerne, N. Y. This trap is designed to kill small animals instantly, and to this end the inventor provides a pivoted bait-plate with one end turned up to form a jaw, and a spring frame which, when the trap closes, will spring downward, striking the animal and causing it to be caught between the frame and the jaw of the bait-plate.

Designs.

PLATE. — ARTHUR S. HIGGINS, Manhattan, New York city. The border of the plate is a ribbon of tulips with their leaves. A second and inner border of fancy foliate figures is also employed.

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(7940) C. R. asks: If it were possible to build a tower 100 miles high and from the top of such a tower a ball be dropped, would the ball strike the earth exactly toward the center of gravity? Would the motion of the earth imparted to the ball throw the ball out of a direct line toward the center, not considering the attraction the tower has for the ball. A. A ball dropped from a height strikes the earth to the east of the vertical line in which it started. All parts of the earth move with the same angular velocity, but not with the same linear velocity. The smaller the circle of rotation the slower the velocity of motion. As the ball drops it maintains the velocity of motion toward the east, which the point had from which it was dropped. As it approaches the center of the earth, it comes to points which have a slower velocity than it has. It will, therefore, be moving to the east faster than the place to which it has come. This has been proved by dropping balls into deep mines.

(7941) W. G. asks: 1. Could $\frac{1}{32}$ inch brass be used instead of $\frac{1}{16}$ inch for the spool of the ammeter described in SUPPLEMENT, No. 1215. A. Any thickness of brass can be used which will hold the wire without bending. 2. How many pounds of No. 31 copper wire does it take for the high tension transformer described in SUPPLEMENT, No. 1087? A. About 48 pounds by calculation. You will probably not get so much in as you cannot wind it perfectly true. 3. How many layers is there on the secondary of high frequency transformer. A. One.

(7942) B. U. S. writes: I desire to know what size and amount of wire to use to convert eight light dynamo in SUPPLEMENT, No. 600, pages 9586 to 9590 inclusive of July 2, 1887. I wish to change to 500 volt motor. Have you a SUPPLEMENT with this information? A. It is not feasible to change the eight light dynamo into a motor to run upon a 500 volt circuit. The commutator could not stand it. You would need to wind each of the armature coils with about 40 turns of No. 28 wire and use a resistance of about 400 ohms with the present field. This is not figured out accurately because it is not desirable to make the change. It would be far better to build a new machine.

NEW BOOKS, ETC.

EIN LENKBARER FLUGAPPARAT. Von Dr. Constantin Danilewsky. Charkow, Russia: Author's Edition. 1900. Octavo, 82 pages. Illustrated. Price, paper 75 cents.

Danilewsky's experiments in aerial navigation have already been described in the SCIENTIFIC AMERICAN. The present monograph contains a very thorough, and it must be confessed, convincing account of the possibilities of mechanical flight. Dr. Danilewsky writes with the confidence of one thoroughly versed in his science. He claims much for his experiments, but not too much. His monograph is valuable because it contains the only exhaustive account of what he has really accomplished.

SYMBOLISM OF THE HUICHOL INDIANS. By Carl Lumholtz. Memoirs of the American Museum of Natural History. Volume III. Anthropology II., May, 1900. Quarto. Pp. 228, plates and illustrations.

During the years 1890 to 1898 the author made three expeditions to Mexico under the auspices of the Museum. The author spent ten months among the Huichols in 1895 and obtained valuable information on the state of their culture. The author has produced a most solid and satisfactory contribution to ethnological research and the Museum is specially to be commended for the substantial and sumptuous manner in which the book has been clothed. The illustrations are good and the plates are specially fine.

TECHNOLOGISCHES LEXIKON. Handbuch für alle Industrien und Gewerbe. Redigirt von Louis Edgar Andés. Illustrated. Parts 2-5. Vienna: A. Hartleben. Large Octavo. Price, per part, 70 cents.

The parts of this new lexicon which lie before us extend from "Arsenhüttenbetrieb" to "Eichenholzfärbungen." Long articles are to be found under the headings "Ausdehnungskoëffizienten verschiedener Körper," "Baumwollgewebe," "Bleigewinnung," "Desinfektion," etc. The illustrations which accompany the text are, for the most part, excellent woodcuts. The parts which, up to the present, have come to our notice deserve unstinted praise for the evident care which the author has taken in their preparation.

DIE SOCIALEN AUFGABEN DES INGENIEURBERUFES UND DIE BERECHTIGUNGSFRAGE DER HÖHEREN SCHULEN. Eröffnungsrede zur 40. Jahresversammlung des Deutschen Vereins von Gas-und Wasserfachmännern. Von Generaldirektor W. v. Oechelhaeuser, Dessau. München: R. Oldenbourg. 1900.

DIE ELEKTRISCHE VOLLBAHN BURGDORF-THUN. Separat-Abdruck aus der "Schweizerischen Bauzeitung." Zürich: Ed. Rascher, Meyer und Zeller's Nachfolger. 1900.

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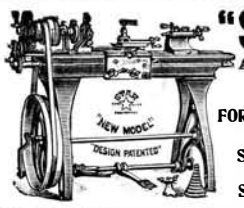

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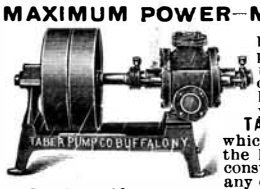

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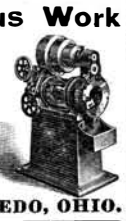

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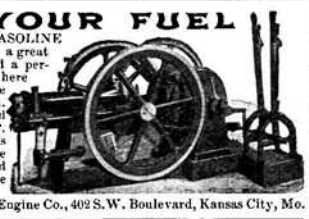

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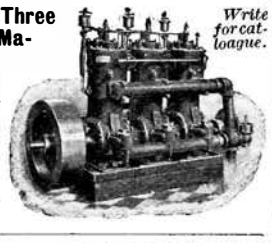

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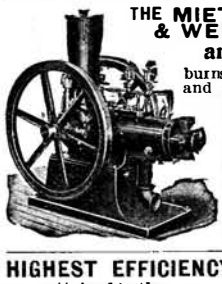

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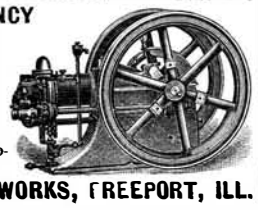

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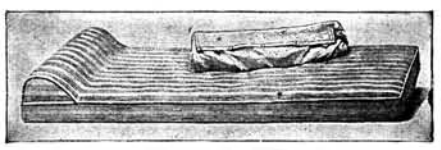

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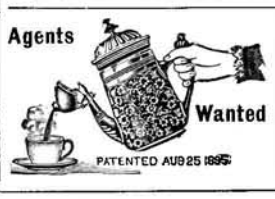

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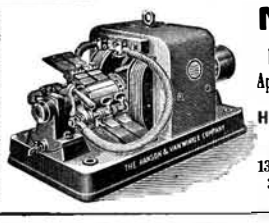

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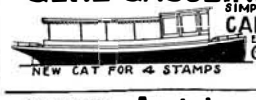

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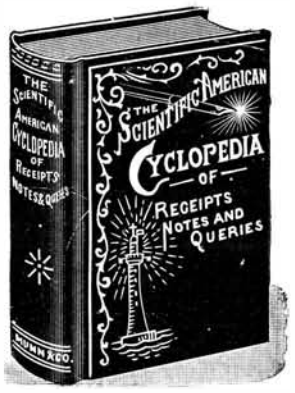

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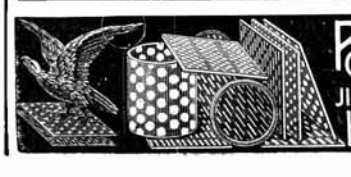

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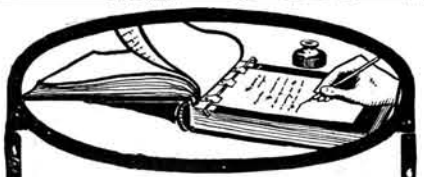

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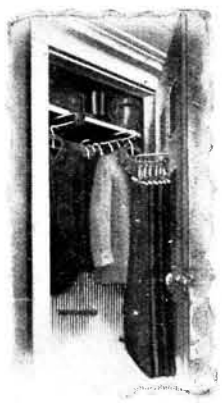

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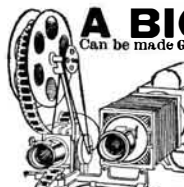

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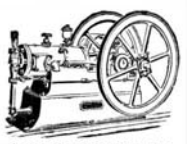

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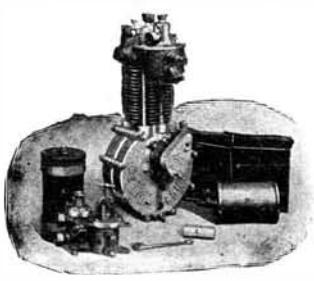

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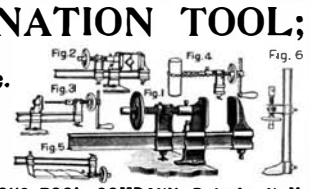

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